

DISSECTION MANUAL

FOR

DENTAL STUDENTS



Sujatha Kiran

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for
Dental Students

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Dissection Manual for Dental Students

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Dedicated to

My Father

Sri Pendyala Nageswara Rao

Preface

Anatomy is the study of structure of the human body. The gross anatomy describes the structures as they are seen in the body. To study them, dissections are performed on the cadaver.

Human anatomy conventionally is studied as regional anatomy. The body is divided into six to seven regions and the structures located in a particular region are described in dissection manuals and standard textbooks.

The dissection manual is a practical guide in the dissection hall to unfold the position, relations and functions of the structures seen. This book is aimed at students pursuing dental course. They need to do dissections of Head and Neck and Brain. All other important organs are expected to be studied from the dissected body.

Knowledge of the basic architecture of the body is an essentiality to understand the structure of any region. So, an introductory chapter is given here along with notes on how to perform dissection.

Chapter on Head and Neck starts with an introductory note. This gives an outline of arrangement of structures in that part and their functional specialization. This is followed by smaller segments of dissection regions. Each region describes the structures seen in that particular region with a pictorial depiction. This carries information needed to identify the structures.

Chapter on Central Nervous System (CNS) gives a detailed dissection and description of the concerned parts. Knowledge of the CNS is very much essential for any doctor treating the patients. Dental students can collaborate with the medical students in removing the spinal cord.

Living and surface anatomy is incorporated at places to make the student understand the correlation between the structures that are seen in the cadaver and the functions they perform in the living.

This book is aimed at undergraduate student. After seeing and identifying the structures, they are expected to read the details from a standard textbook.

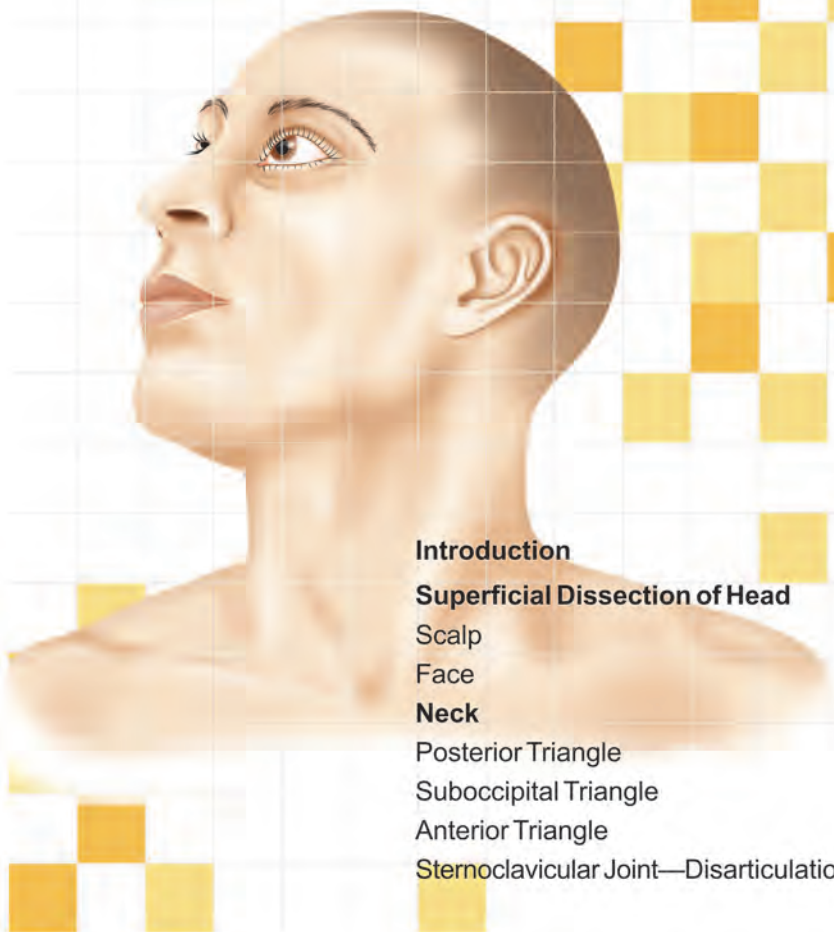
Sujatha Kiran

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CHAPTER 1

HEAD AND NECK



Introduction

Superficial Dissection of Head

Scalp

Face

Neck

Posterior Triangle

Suboccipital Triangle

Anterior Triangle

Sternoclavicular Joint—Disarticulation

Inlet of Thorax

Thyroid and Parathyroid

Neurovascular Bundle

Digastric Triangle

Deep Dissection of Head

Temporal and Infratemporal Regions

Submandibular Region

Removal of Spinal Cord

Cranial Cavity

Orbit

Nose

Mouth

Pharynx

Larynx

Eyeball

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INTRODUCTION

The head and neck is the upper part of the trunk. Skull forms the skeleton of the head. It is a bony box. The main function of skull is protection. The brain is protected in the cranial cavity. The anterior part of the skull forms the facial skeleton. It lodges the sense organs and the receiving ends of the respiratory and digestive system. As you can feel, note that there is a thin area between the skull and the skin. In our dissection we are studying this area under the superficial dissection of the head. The skull has only one movable bone, the mandible. This bone articulates to form the temporomandibular joint. Muscles which act at this joint form the temporal and infratemporal regions. The eye, ear, nose and mouth along with their associated structures are located within the bony box, the skull. All these structures are studied under the heading deep dissection. Most of these being midline structures they are studied in sagittal section.

The neck is the part connecting the head with the thorax below. The cervical vertebrae form the axis for this. The prominent sternocleidomastoid muscle forms as a landmark to separate the neck into two triangles, a posterior muscular part and an anterior visceral triangle. The posterior triangle is made up of musculature spanning from the vertebrae posteriorly to the scapula, clavicle and the ribs laterally and inferiorly. It is wider inferiorly. The viscera are lodged in the anterior triangle. It is wider superiorly and narrower inferiorly. The neurovascular bundle lies between the musculature and the viscera (**Fig. 1**).

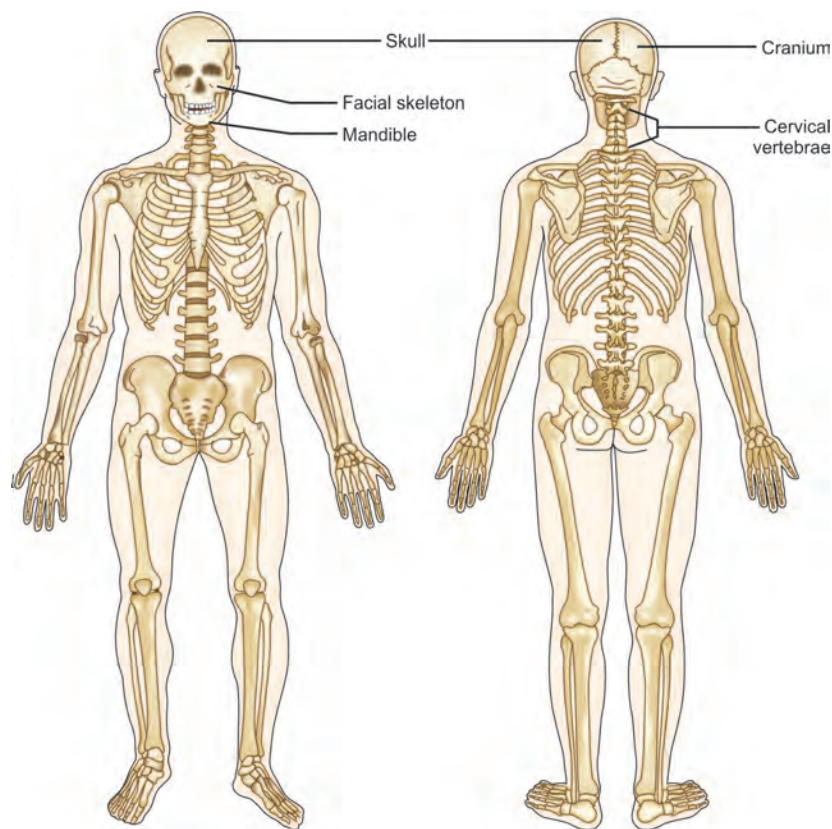


FIGURE 1 Head and neck

SUPERFICIAL DISSECTION OF HEAD



SCALP

Scalp is the region on the top of the skull. **Anteriorly** it extends up to the superior orbital margin. Here the forehead is included. **Posteriorly** it extends up to the external occipital protuberance and superior nuchal line. **Laterally** it extends up to the zygomatic arch. The scalp is made up of five layers—skin superficial fascia with neurovascular bundle occipitofrontalis muscle, loose areolar tissue and the pericranium.

SKELETON

Norma Verticalis (Fig. 2)

This is the external surface of the skull, viewed from above. Note the following features:

Frontal bone: This occupies the anterior part of this region.

Frontal tubers: These are the prominent elevations on the front. These are more prominent in females

Parietal bones: They occupy the central part of the norma verticalis. Note the emissary foramen. This permits the emissary veins.

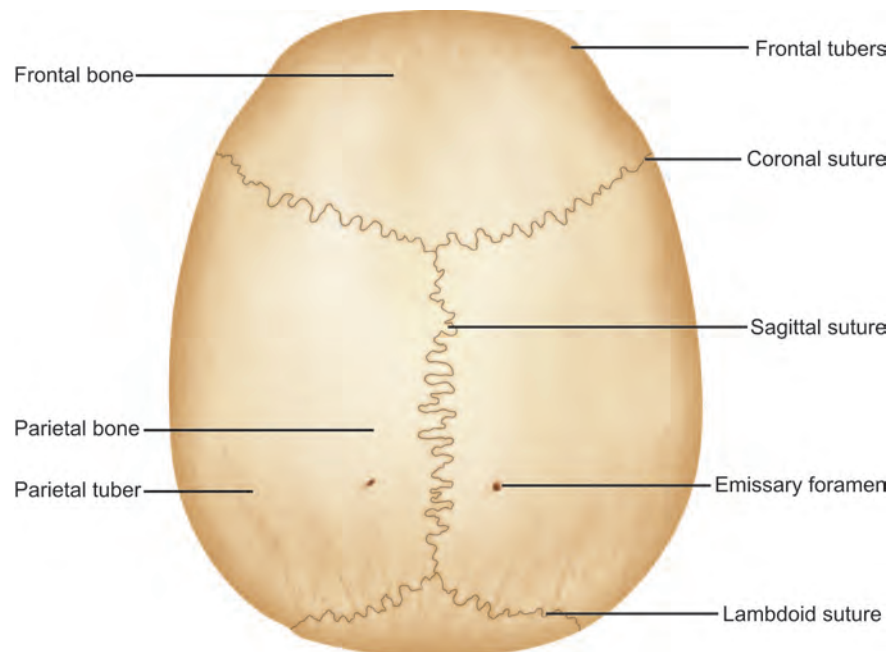


FIGURE 2 Norma verticalis

Parietal tubers: They form the lateral prominence on the parietal bone.

Coronal suture: This is where the frontal bone meets the two parietal bones.

Sagittal suture: This is where the two parietal bones meet.

Lambdoid suture: This is where the two parietal and the occipital bones meet.

Occipital bone: This occupies the posterior part of the skull

Vertex: This is the midpoint on the top of the skull.

Norma Frontalis (Fig. 3)

Identify the following features on the skull in the anterior aspect.

Glabella: This is the midline elevation where the superciliary arches meet.

Superciliary arches: These are the elevations above the supraorbital margins.

Supraorbital margins: These are the sharp margins forming the superior border of orbit.

Supraorbital foramen or notch: See this nearer to the medial side on the supraorbital margin. It can be either a foramen or a notch on the skull.

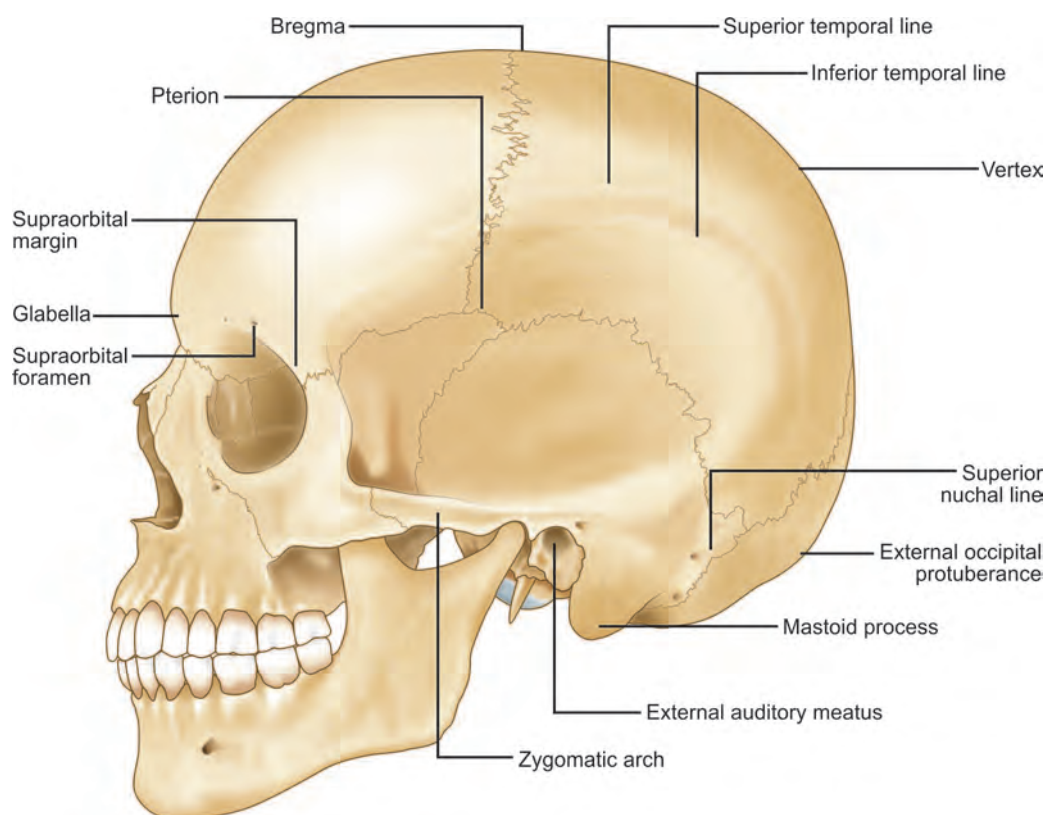


FIGURE 3 External features of skull

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Norma Lateralis (Fig. 3)

On the lateral side identify:

Zygomatic arch: This is the bony elevation felt between the lateral margin of the orbit and the pinna of the ear.

Superior temporal lines: Note these superior and inferior temporal lines above the zygomatic arch.

External auditory meatus: Note this opening in front of the mastoid process

Mastoid process: This is the bony prominence seen behind the auditory meatus.

Norma Occipitalis (Fig. 3)

On the posterior side identify:

External occipital protuberance: This is a prominence on the posterior aspect of the occipital bone in the midline.

Superior nuchal line: This is the line radiating from the external occipital protuberance.

Supreme nuchal line: This is the line radiating from the external occipital protuberance, but thinner and above the superior nuchal line.

SURFACE ANATOMY (Fig. 4)

- On the living feel, the **supraorbital margins**. The **supraorbital notch** can be easily felt on the living, but not the foramen.
- Feel the subcutaneous skull throughout the region. Note the **frontal and parietal tubers**.
- On the lateral side, in front of the external ear feel the **zygomatic arch**.
- **Superficial temporal artery** pulsations can be felt in front of the external ear, above the zygomatic arch.
- Feel the **mastoid process** behind the external ear, and the **external occipital protuberance** in the midline posteriorly.

Dissection: Raise the neck on a block so that the total scalp can be easily visualized. Make a midline incision from glabella to the external occipital protuberance. A coronal incision from one pinna of the ear to the other. Make a circular incision from glabella—superciliary arches—zygomatic arch—upper part of mastoid process—external occipital protuberance. Remove the total skin upto vertex starting from the periphery. Here the skin is adherent with the deeper muscle layer by connective tissue. This connective tissue lodges the neurovascular bundle of the skin, so special care is to be taken while reflecting the skin. The surface is to be kept wet constantly and the undersurface of the skin is to be checked for protruding hair follicles. They can constantly be felt like bristles to the cutting knife.

SUPERFICIAL FASCIA

The superficial fascia is fibrous, attaches the skin to the occipitofrontalis muscle. It is also firmly attached to the blood vessels. It has the cutaneous neurovascular bundle. They enter the scalp from the periphery and move towards the vertex. Nearer to the circumference they are deeper to the muscle. They pierce through the muscle to reach the superficial fascia. The arteries can easily be identified as they bulge. The veins can be identified by their blue coloration. The nerves accompany the blood vessels.

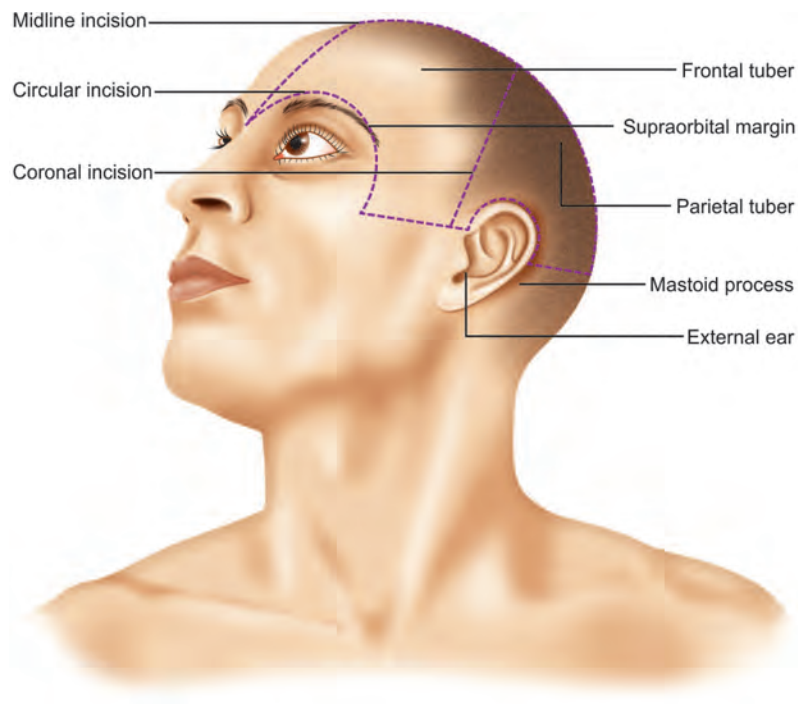


FIGURE 4 Dissection lines and surface anatomy

Cutaneous Nerves—Anterior Aspect (Fig. 5)

Dissection: The neurovascular bundle pierces through the deeper layers of the scalp to supply the skin. Try to locate the following neurovascular bundle and the frontal belly of the occipitofrontalis muscle in the anterior aspect of scalp.

Supratrochlear nerve and blood vessels: These are fine branches located one finger breadth from the glabella.

Supraorbital nerve and blood vessels: Feel for the supraorbital notch or foramen trace the thick neurovascular bundle through the frontal belly of occipitofrontalis.

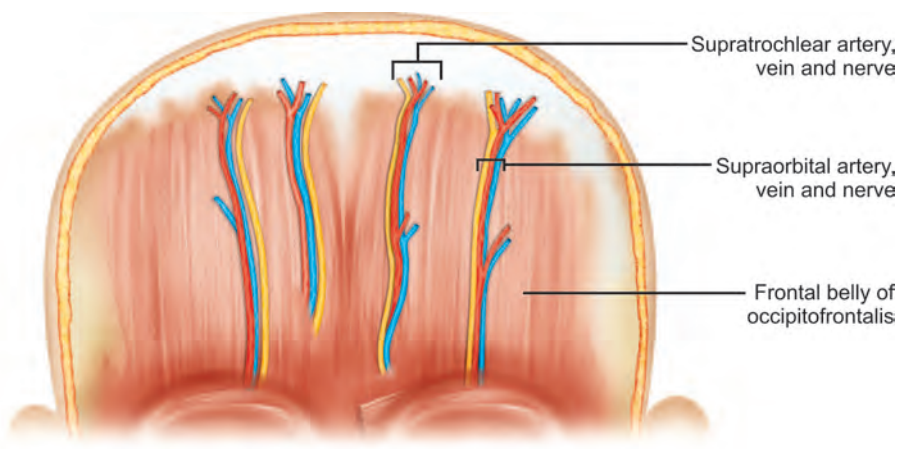


FIGURE 5 Anterior aspect of scalp

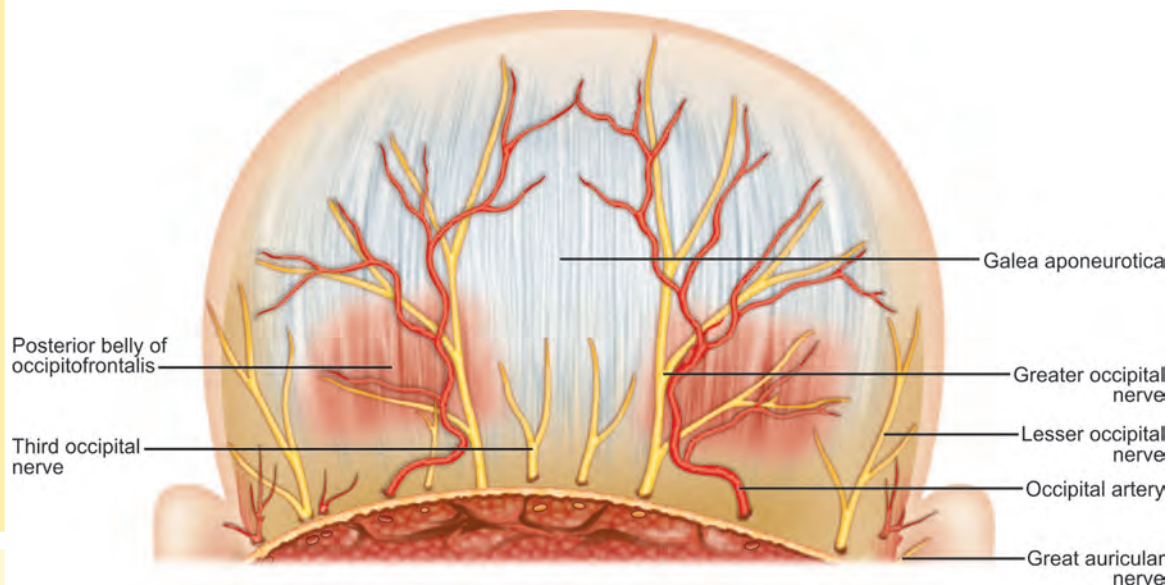


FIGURE 6 Posterior aspect of scalp

Auriculotemporal nerve and superficial temporal blood vessels: Feel the zygomatic arch near the pinna of the ear trace the thick anterior and posterior branches of the neurovascular bundle traversing to the vertex. It is easy to locate the artery, which is bulging and anterior most structure. The nerve is thick, behind the artery and deeply placed.

Frontal belly of occipitofrontalis muscle: This is relatively a thicker belly. It is inserted into the skin near the eye brow. It has two bellies, the right and the left. An aponeurosis can be easily seen between the two bellies.

Cutaneous Nerves—Posterior Aspect (Fig. 6)

Dissection: Turn the body to a prone position and reflect the skin from the vertex up to the external occipital protuberance. Try to locate the neurovascular bundle at the posterior half of the scalp. Identify the deeply placed brown fibres of the occipital belly of the occipitofrontalis muscle fibres.

A wide central area upto the vertex is supplied by the upper three posterior rami. The first cervical branch joins the second to form the greater occipital nerve.

Greater occipital nerve and occipital artery: These are seen one finger breadth from the external occipital protuberance. The greater occipital nerve is 0.5 mm thick and can easily be identified. Note the greater occipital nerve passing through the occipitofrontalis muscle. The occipital artery is tortuous and generally can be easily identified. It runs lateral to the nerve, gives branches to supply up to vertex.

Third occipital nerve: It is a small branch and supplies nearer to midline.

Great auricular nerve: Posterior branch of the great auricular nerve is seen in groove between the pinna and the mastoid process. This supplies the back of the ear lobule and the adjoining scalp.

Lesser occipital nerve: This nerve runs along the posterior border of the sternocleidomastoid muscle. Clean this nerve. It gives branches to the lateral aspect of the skin of the back. Branches of this nerve are seen between the above two nerves.

Occipital belly of occipitofrontalis muscle: This has two bellies, the right and the left. Identify this thin muscle belly arising from the supreme nuchal line. Occipital belly of occipitofrontalis is the muscle of the posterior aspect of the scalp. Trace these thin flat fibres from the supreme nuchal line to the vertex. Note the aponeurosis between the right and left bellies and also the epicranial aponeurosis between the frontal and occipital bellies of the occipitofrontalis muscle. The occipitofrontalis is a single muscle. This muscle along with the galea aponeurotica acts together to raise skin of the forehead. Perform this action on your body and feel the contraction of both the bellies of occipitofrontalis.

Galea aponeurotica: It is the intermediate aponeurotic part of the muscle, laterally merges with the temporal fascia.

Nerve supply: Both the bellies are supplied by the facial nerve.

LOOSE AREOLAR TISSUE

Turn the body back to the supine position and dissect:

Dissection: Cut across the galea aponeurotica from one pinna to the other pinna, put a scalpel beneath and appreciate this loose areolar tissue. In front of the vertex you may see the emissary vein passing through the parietal foramen.

PERICRANIUM

Appreciate the vault of the skull here. It is covered by the periosteum. This periosteum is called the pericranium.

Dissection: Alternatively the posterior part of the scalp can be dissected along with the back dissection. This would avoid turning the body from supine to prone, prone to supine position.

FACE

SKELETON (Fig. 7)

Identify the features on the articulated skull.

Glabella: This is the elevation in midline.

Superciliary arches: They extend out from the glabella.

Nasion: This is the depression on the bridge of the nose, where nasal bones join the frontal bone.

Cheek elevation: It is formed by zygomatic bone.

Maxilla: Forms a major part of the facial skeleton and lodges the upper teeth.

Symphysis menti: This is the part where two halves of the mandible meet in the midline.

Angle of the mandible: This is the posterior sharp pointed end of the bone.

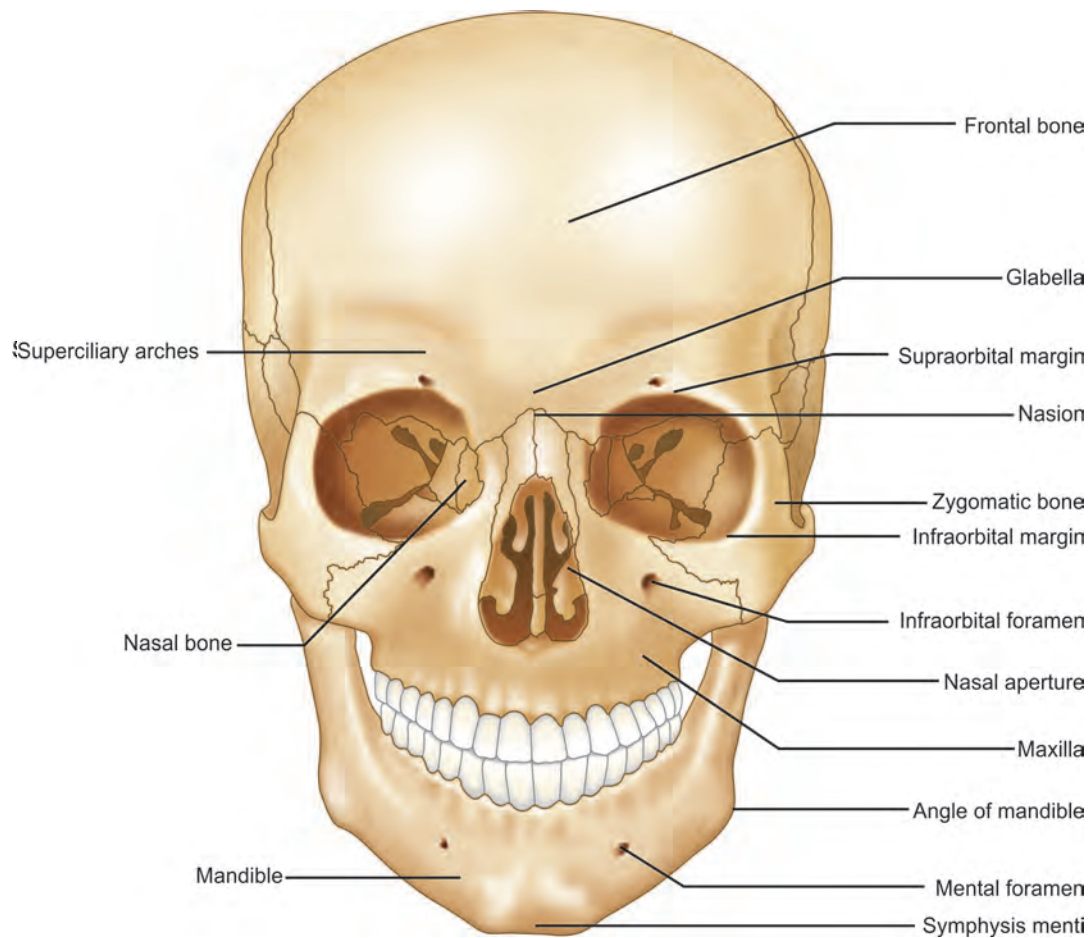


FIGURE 7 Skeleton—anterior aspect

Orbital margin: This is formed superiorly by the frontal bone, medially by maxilla, inferiorly by maxilla and zygomatic bone and laterally by the zygomatic bone.

Nasal aperture: See that it is formed by the nasal bone and maxilla.

Infraorbital foramen: Note this below the inferior orbital margin.

Mandible: See the ramus and the body of the mandible.

Mental foramen: See this foramen on the mandible.

SURFACE ANATOMY (Fig. 8)

Identify the following on the living body and correlate it with the skull.

Palpebral fissure: This is the gap between the two eyelids.

External nose: This is formed by the **bridge of the nose:** This is the bony part of the nose, **alae of the nose**—feel them, they are formed of cartilage and the **anterior nasal aperture**—is the external opening of the nose.

Cheek: Feel the hard zygomatic bone beneath your cheek.

Maxilla: Feel the maxilla, note the upper jaw formed by this.

Mandible: Feel and move it in your fingers. It forms the lower jaw.

Oral fissure: This is the gap between the two lips.

Facial artery pulsations: Clench the teeth feel the masseter. Put your fingers in front of the muscle and feel the pulsations of the artery.

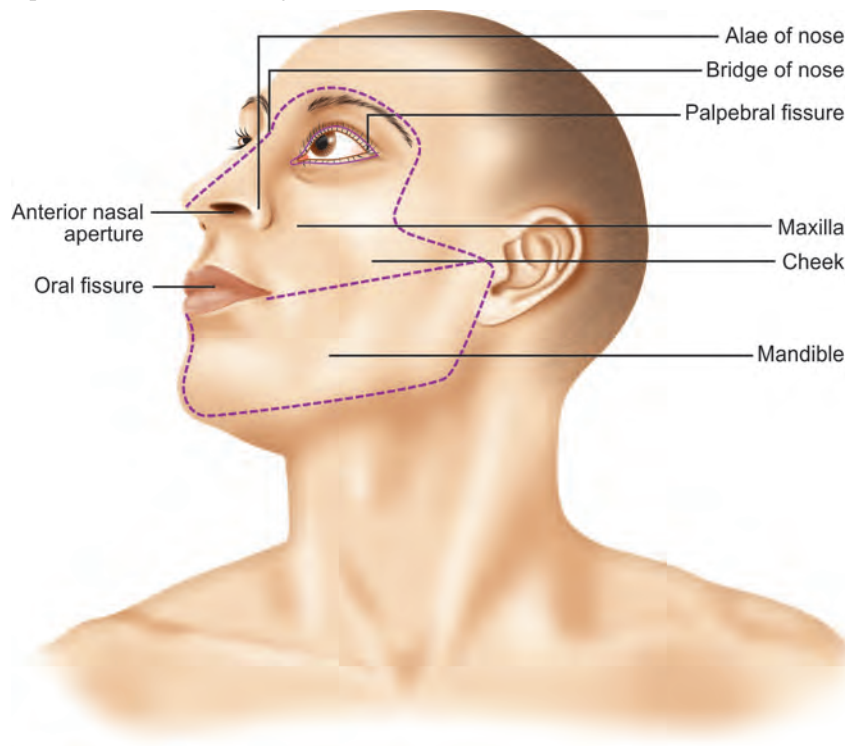


FIGURE 8 Dissection lines and surface anatomy—face

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Superficial temporal artery pulsations: Put the fingers in front of the pinna of the ear over the zygomatic arch and feel the pulsations.

Dissection: Make a vertical incision from the nasion to the symphysis menti. Make a horizontal incision from the angle of the mouth to the ear. Make a horizontal incision from the symphysis menti to the angle of the mandible to the mastoid process. Make an incision along the margin of the eyelid. Reflect the skin and totally remove the skin. Here the skin is very thin and the muscles of facial expression are inserted into it. While reflecting the skin, constantly make sure that the muscle is not damaged.

MUSCLES OF FACIAL EXPRESSION (Fig. 9)

The muscles of facial expression belong to the panniculus carnosus group of musculature. They control the orifices of the special senses. They have a bony origin and a cutaneous insertion, and so are capable of moving the skin of the face and scalp. Try to locate each of these muscles.

Muscle of the Eyelid

Corrugator supercilii: This extends from the bridge of the nose to the forehead. This produces vertical wrinkles of the forehead skin.

Orbicularis oculi: Identify this muscle within the eyelid. It is an elliptical muscle. It takes origin from the medial palpebral ligament. It has a **palpebral part** within the eyelids and this gently closes the eyelids. It has an **orbital part** which extends on to the adjoining orbital margin. This part screws

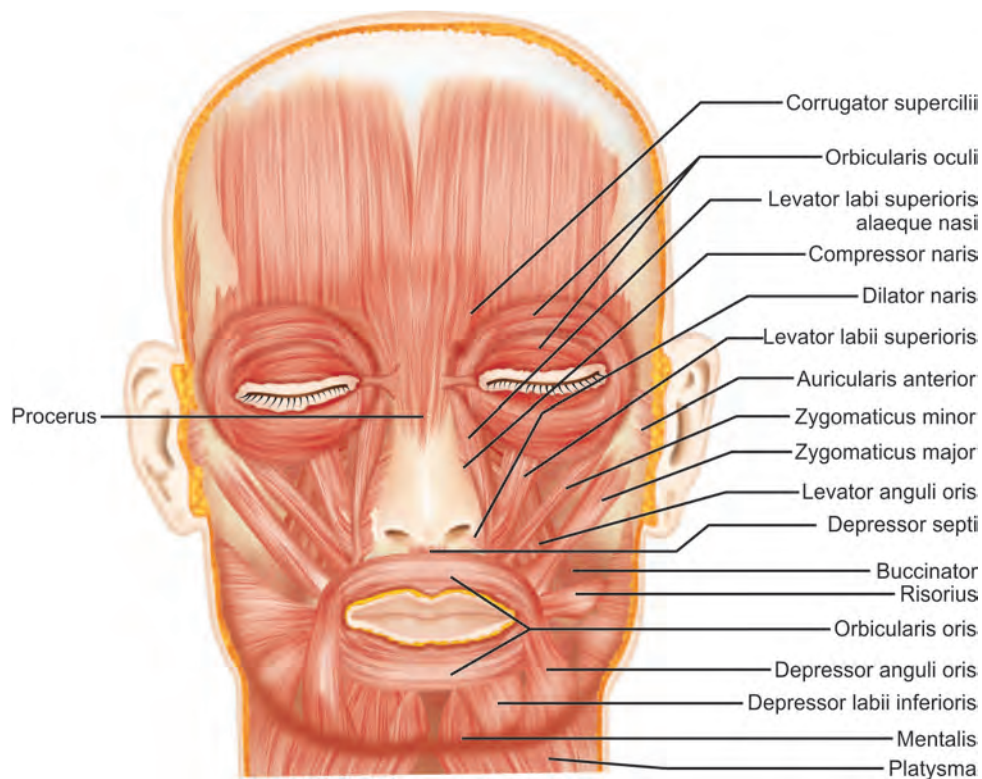


FIGURE 9 Muscles of facial expression

the lids towards the medial side. It has a **lacrimal part** which is attached to the lacrimal sac and opens the lacrimal sac.

Muscles of the Nasal Aperture

Compressor nares: This is seen on the bridge of nose.

Dilator nares: This is inserted into the alae of the nose.

Depressor septi: This is inserted into the septum from the maxilla.

Levator labi superioris alaeque nasi: This muscle extends from medial side of orbital wall to the alae of the nose.

All the muscles of external nose are small and have a limited movement in humans. They perform the movements specified in their names.

Muscles of Oral Aperture

Orbicularis oris: This is the sphincter of the oral aperture. It is an elliptical muscle extending from the maxilla to the mandible in the midline.

The following muscles stretch from the neighboring bones into the lips, like the spokes of a wheel and act as dilators.

Zygomaticus major: This extends from zygomatic bone to the angle of oral aperture.

Zygomaticus minor: This extends from zygomatic bone to the angle of oral aperture. This muscle lies medial to the major.

Levator anguli oris: This extends from below the infraorbital foramen to the angle of oral aperture.

Levator labi superioris: This extends from above the infraorbital foramen to the upper lip.

Depressor anguli oris: This extends from the mandible to the angle of the oral aperture.

Depressor labi inferioris: extends from the mandible to the lower lip.

Risorius: This extends from the parotid fascia to the angle of the oral aperture. It is a smiling muscle.

Muscles of the Ear

Auricularis anterior: Lies in front of the ear.

Auricularis superior: Lies superior to the ear.

Auricularis posterior: Lies posterior to the ear.

Other Muscles

Corrugator supercilii: This extends from the bridge of the nose to the eyebrow.

Procerus: This extends from the bridge of the nose into the skin over glabella.

Mentalis: This extends from the mandible into the skin of the chin.

These small muscles act on the nearby skin.

BLOOD VESSELS (Fig. 10)

Dissection: Locate the superficial temporal artery in front of the external auditory meatus. Here it is superficial, not covered by musculature. Trace the artery and all its branches from the upper border of the parotid gland to the scalp. Similarly identify the facial artery along the lower border of the mandible in front of the masseter muscle. Again here it is superficial. From here trace it up to the angle of the eye. Trace all its branches on the way.

Superficial temporal artery: It is the terminal branch of the external carotid artery. It ascends up into the scalp and supplies the temporal area above the zygomatic arch. The **transverse facial artery**—Locate this artery below and parallel to the zygomatic arch. It is a branch of the superficial temporal artery. It runs parallel to the zygomatic arch and above the parotid duct. It supplies the cheek region.

Facial artery: It is a branch of the external carotid artery. It reaches the face in front of the masseter muscle. It ascends up to the angle of the eye. It is tortuous in its course. This is to accommodate the artery during movements of the mouth. It gives inferior labial artery to supply the lower lip, superior labial artery to supply the upper lip and nasal artery to supply the side of the nose. Trace these arteries. The corresponding veins accompany the artery.

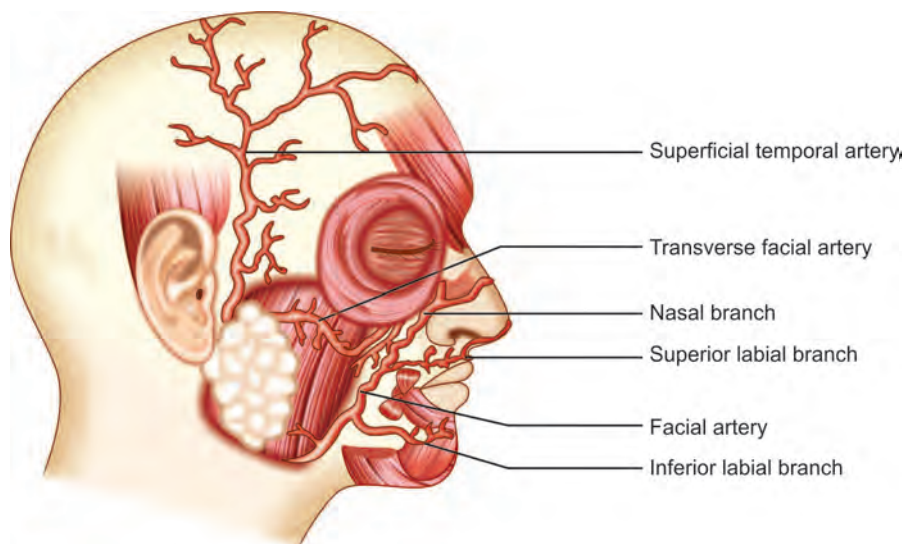


FIGURE 10 Blood vessels—face

FACIAL NERVE (Fig. 11)

The facial nerve is the 7th cranial nerve and is the motor nerve of this region. It supplies all the muscles of facial expression. Its branches are to be located around the parotid gland. They enter the face deep to the parotid gland. The branches of the nerve appear along the borders of the parotid gland, pass deep to the muscles and supply them on their deeper aspect. The distribution is highly variable. Following gives standard distribution.

Dissection: Identify the branches of the facial nerve along the borders of the parotid gland as described below and trace them to their destinations by cutting through the muscles.

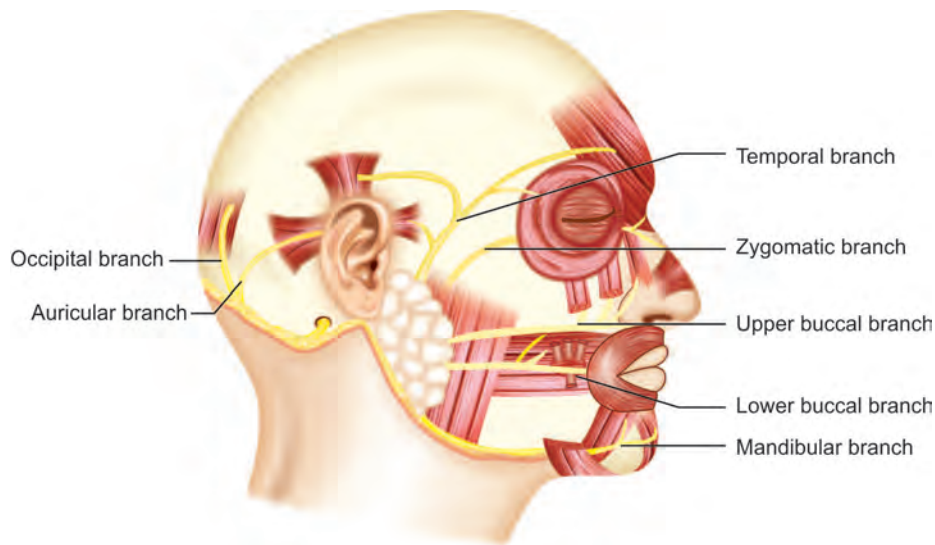


FIGURE 11 Facial nerve—face

Temporal branch: It is seen along the upper border of the parotid gland in front of the superficial temporal artery. This nerve runs parallel with the artery and supplies the auricularis superior, anterior frontal belly of occipitofrontalis and orbicularis oculi.

Dissection: Cut across the zygomaticus major and zygomaticus minor and lift the muscles superiorly.

Zygomatic branch: This runs parallel to the zygomatic arch, supplies the muscles zygomaticus major and zygomaticus minor arising from the zygomatic bone. It runs further to supply the muscles of nose. Trace these branches.

Upper buccal branch: This leaves the parotid gland anteriorly. Trace this nerve. It runs between the transverse facial artery and the parotid duct. Trace it forwards into the muscles of upper lip, i.e. orbicularis oris levator labi superioris and levator anguli oris.

Lower buccal nerve: Trace this nerve from the anterior border of the parotid gland, below and parallel to the parotid duct and supplies the buccinator and risorius muscle.

Dissection: Cut across the risorius, depressor anguli oris and reflect the muscles downwards.

Mandibular branch: This arises near the lower border of mandible (can be seen in the neck dissection). It enters the deep surface of depressor anguli oris and depressor labi inferioris to supply them. Trace these branches.

Cervical branch: This supplies the platysma and can be seen in neck dissection.

Occipital branch: This supplies the posterior auricular muscle.

PAROTID GLAND (Fig. 12)

Parotid gland is a salivary gland. It is the biggest of the salivary glands. It is enclosed in the deep fascia of the neck. It is called parotid fascia. Note the irregular shape of the gland. Superiorly it extends up to the zygomatic arch and the external auditory meatus. You have already noted the nerves and blood vessels in relation to the gland.

Parotid duct: Trace this from the middle of the anterior border of the gland. Trace it forward between the upper and lower buccal nerves. Note that it pierces the buccal pad of fat and the buccinator muscle. Its opening in the oral cavity can be seen at a later dissection.

Dissection: The parotid gland encloses the neurovascular bundle reaching the face. You try to identify them by dissecting through the gland.

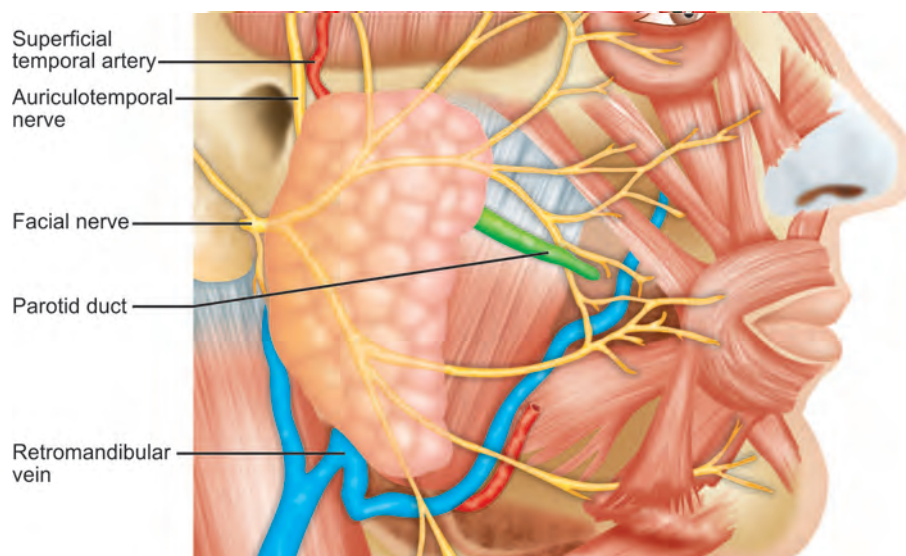
Facial nerve: This is the most superficial of the structures within the gland. Dissect the branches of the nerve into the gland. Its arrangement in the gland is variable. However in general it is seen as two trunks, an upper and a lower. A small part of the gland is clasped between the two divisions. The part superficial is considered as the superficial part. Slowly remove this.

Retromandibular vein: Identify this vein running vertically within the substance of the gland. It is formed by the union of the *superficial temporal and the maxillary veins*. It divides into an anterior and a posterior division within the substance. Locate these branches.

External carotid artery: Trace this artery in the gap between the posterior border of the mandible and the mastoid processes. Trace the superficial temporal artery and the maxillary artery which are its terminal divisions. The part of the gland that is removed to trace these vessels is the deep part of the gland.

Lymph nodes: Many a lymph nodes were removed during the dissection and these are the parotid lymph nodes.

Trigeminal nerve branches supply the skin of the face. The nerve fibres are very thin, pass through the skull before reaching the skin. Try to locate them as per their position, and it is not essential to trace all the branches.



SENSORY NERVES—BRANCHES OF TRIGEMINAL NERVE (Fig. 13)

Trigeminal nerve is the 5th cranial nerve and is sensory to the skin of the face. It has three divisions—the ophthalmic, maxillary and mandibular. The terminal branches of these divisions reach the face through the foraminae in the skull.

Dissection: Reflect the muscles and identify the deeply placed branches of the following nerves.

OPHTHALMIC DIVISION

Supratrochlear nerve and supraorbital nerve: These nerves were already identified in the dissection of the scalp. Relocate them and trace supratrochlear nerve through the orbicularis oculi to the trochlea and the supraorbital nerve to the supraorbital notch near the medial aspect of the orbit.

Lacrimal nerve: This is a very small branch piercing the upper eyelid on its lateral aspect.

Infratrochlear nerve: This is a very small branch on the bridge of the nose medial to the medial palpebral ligament.

External nasal nerve: This is a very small branch on the bridge of the nose. It pierces to the surface between the nasal bone and alae of the cartilage.

MAXILLARY DIVISION

Zygomaticotemporal nerve: It is a very small branch piercing through the temporal fascia above the zygomatic arch.

Zygomaticofacial nerve: It is a very small branch piercing through the zygomatic bone on the face. Try to see its position on a dry skull.

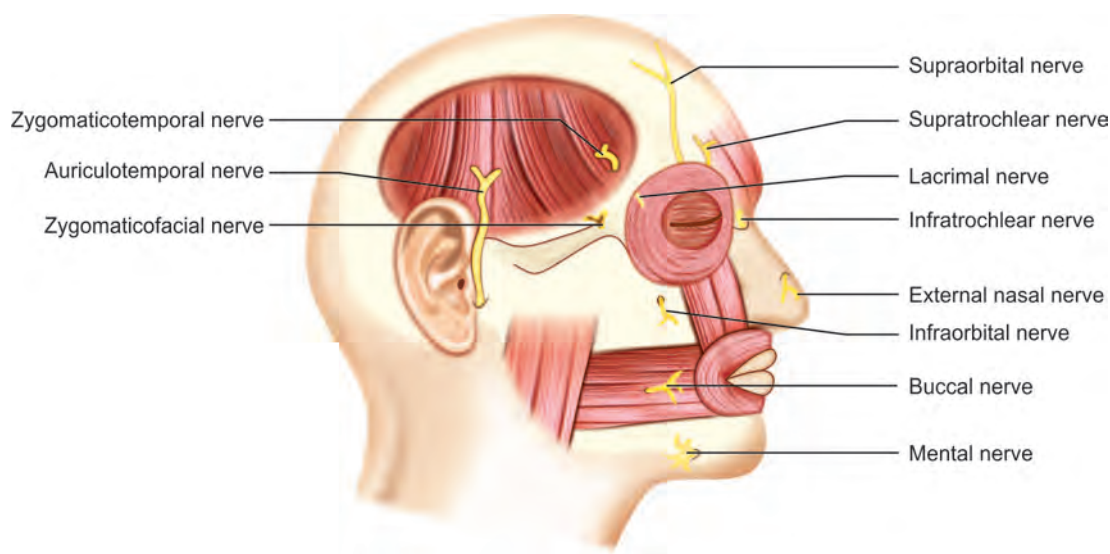


FIGURE 13 Branches of trigeminal nerve

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Infraorbital nerve: This is a thick nerve, reaches the face through the infraorbital foramen. Lift the orbicularis oculi and the levator labi superioris, feel the intraorbital foramen, and locate the thick infraorbital nerve which comes out as a bunch of nerves.

MANDIBULAR DIVISION

Auriculotemporal nerve: This was already identified in the dissection of the scalp. Relocate the nerve and trace up to the upper border of the parotid gland.

Buccal nerve: This is a deep branch. It passes through buccal pad of fat and buccinator muscle to supply the skin of the cheek. Identify this at this stage so that it can be traced in a later deeper dissection.

Mental nerve: This is a thick nerve and reaches the face through the mental foramen. Lift the depressor labi inferioris to locate this nerve.

NECK

Study the neck on a living person and observe the following:

Note that the cervical vertebrae are posteriorly located. The neck extends far higher on the posterior aspect, compared to the anterior aspect. In the midline anteriorly, the trachea and esophagus are located. These are supported by cartilages. The neck can be divided into two parts for convenience of study. The sternocleidomastoid is the key muscle here. It extends from the mastoid process to the sternum and clavicle. It is used to divide the neck into an anterior part, the anterior triangle in front of the sternocleidomastoid and a posterior part, the posterior triangle behind the sternocleidomastoid.

The **posterior triangle** is made up of vertebral musculature. It is narrow superiorly, but widens inferiorly and spans from the vertebral processes to the scapula, clavicle and the upper ribs. It presents a layered appearance. The most superficial group belongs to the upper limb, the middle group belongs to the erector spinae group of musculature. The deep group belongs to the rotator group of vertebral musculature.

The **anterior triangle** is made up of visceral structures. In its upper part it is the pharynx, the common passage of both respiratory and digestive system. Inferiorly it divides into trachea and esophagus. The thyroid and parathyroids form the prominent structures ventral to the trachea.

The **neurovascular bundle** lies between the two. The veins of the neck called the jugular system of veins form a superficial group and a deep group. Branches of the arch of the aorta enter the neck as brachiocephalic artery on the right side and as common carotid artery and the subclavian artery on the left side. They supply the upper limb, head and neck and the brain. The lymph nodes accompany the veins by forming a superficial and a deep group.

9th, 10th, 11th and 12th cranial nerves show their presence in the neck region. The somatic nerves form the cervical and brachial plexuses. The sympathetic chain along with three ganglia are noted here.

SKELETON (Fig. 14)

The skeleton of the neck is formed by the cervical vertebrae. Go to an articulated skeleton and identify the vertebrae. Do a detailed study of the individual vertebrae.

Atlas: This is the first cervical vertebra. It articulates with the skull. Identify its anterior arch, anterior tubercle, lateral masses, foramen transversarium, articulating surfaces on the lateral masses, posterior arch, posterior tubercle and the groove for the vertebral artery on the posterior arch.

Axis: This is the second cervical vertebra. It has an odontoid process which is the detached part of the body of the atlas. It resembles other cervical vertebrae except for this process. Identify the body, odontoid process, transverse process, pedicle, lamina and the bifid spine. This articulates superiorly with the atlas by a pivot joint.

Three to seven vertebrae: Identify the general features of these vertebrae. They present a body, pedicle, the transverse process with a foramen transversarium, anterior tubercle, costotransverse bar and a posterior tubercle, lamina and a bifid spine.

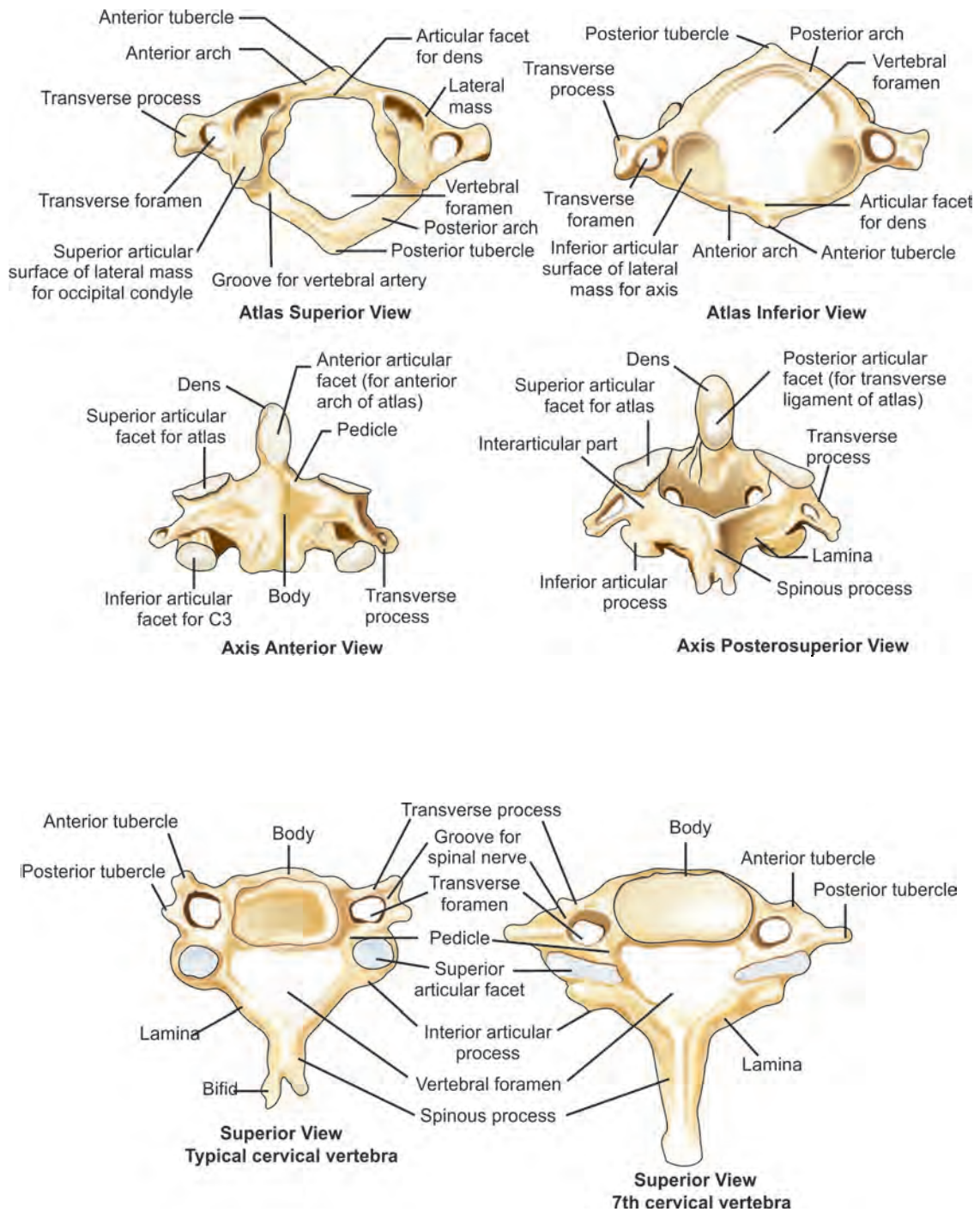


FIGURE 14 Skeleton—neck

SURFACE ANATOMY (Fig. 15)

Most of the following structures were already identified by you. As they form boundaries for this region, they are once again emphasized.

Symphysis menti: It is the lower point of the mandible in the midline.

Lower border of the mandible: Run your fingers from the symphysis menti to the angle of the mandible.

Angle of the mandible: The posteroinferior corner of the mandible at the junction of the body and ramus.

Mastoid process: Put your fingers behind the ear and feel for the downward projection.

Press and identify the gap between the above two points and note the parotid gland in it.

External occipital protuberance and superior nuchal line: Identify these on the skull from the midline to the lower end of the mastoid process and relocate them on the cadaver.

Ligamentum nuchae and cervical spines: Run your fingers along the midline posteriorly till you reach the 7th cervical vertebral prominence.

Acromion process: Lies under the shoulder prominence, feel this by pressing through the deltoid muscle.

Clavicle: It is subcutaneous throughout its length and can be felt all along.

Suprasternal notch: This lies at the upper border of the manubrium sterni between the two clavicles.

Hyoid bone: Run your fingers downward from the symphysis menti along the midline and clasp the bone between your two fingers. You move it by holding the greater cornu of the bone.

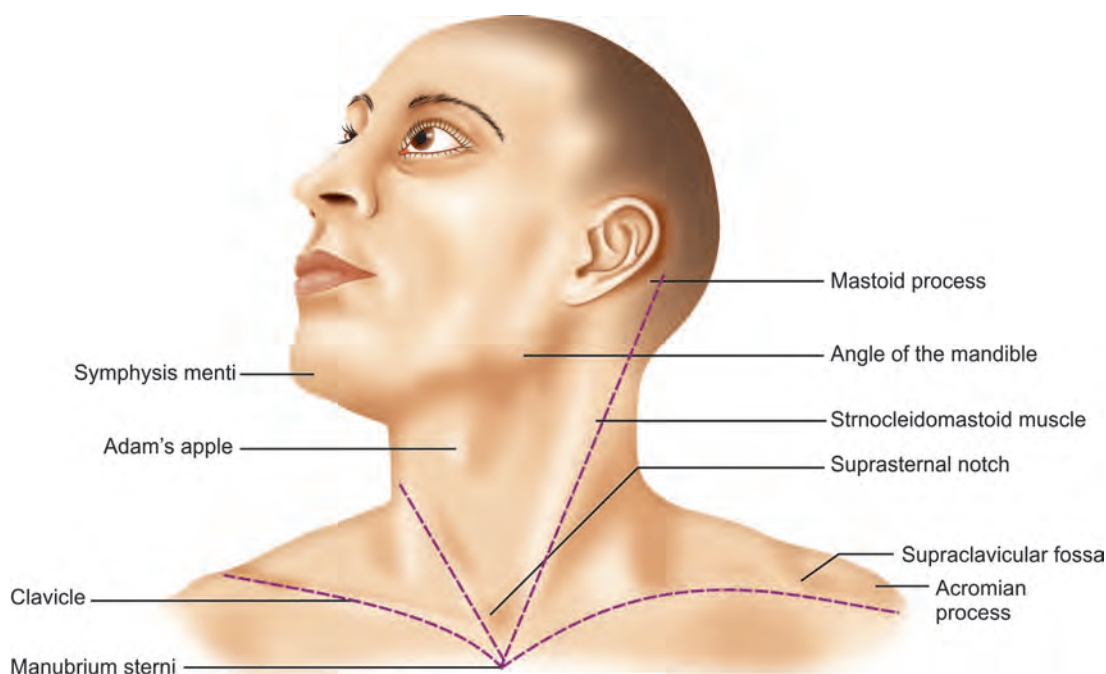


FIGURE 15 Surface anatomy of the neck and skin incision

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Thyroid cartilage: This causes a prominence more pronounced in male members called Adam's apple. Again clasp it between your fingers.

Cricoid cartilage and tracheal rings: These can be felt in the midline below the thyroid.

Supraclavicular fossa: This is a depression above the middle of the clavicle and posterior to the sternocleidomastoid muscle.

Sternocleidomastoid muscle: Turn the head to one side and identify the muscle which stands out extending from manubrium sterni to mastoid process.

External jugular vein: Identify this vein, on a well developed body.

External carotid artery: Feel the hyoid bone, and press your fingers in, to feel the carotid artery.



POSTERIOR TRIANGLE

Posterior triangle is the area between the sternocleidomastoid and trapezius extending from the middle of the clavicle to the superior nuchal line. It is a narrow long strip of triangle. This can be divided into two subtriangles by the inferior belly of omohyoid muscle. The upper part is called the occipital triangle and the lower part is called the subclavian triangle.

BOUNDARIES

Anterior border is formed by the posterior border of sternocleidomastoid muscle; posterior border is formed by the anterior border of the trapezius muscle; roof is formed by the skin, superficial fascia with cutaneous vessels and nerves and platysma muscle; floor is formed by the prevertebral muscles—the semispinalis capitis, splenius capitis, levator scapulae and scalenus medius. Number of structures cross this area to reach their destination in the present study follow the structures as they appear in the dissection.

Dissection (Fig. 15): Support the body with a block placed near the shoulders, so that the neck hangs down stretching it. Turn the head to one side and do the skin reflection as far as you can. (1) Put an incision from the mastoid process to the midline above the manubrium sterni along the anterior border of the sternocleidomastoid muscle. (2) Put a transverse incision from the manubrium sterni to the acromion process (done). Reflect the skin, starting from the sternocleidomastoid muscle to the back. Inferiorly reflect it up to the acromion process, superiorly reflect as far as you can. Skin here is very thin. While reflecting the skin make sure you are able to see the obliquely running muscle fibres of platysma.

Platysma muscle (Fig. 16): It is a thin subcutaneous muscle stretching over the sternocleidomastoid to the clavicle. It helps in tightening the neck skin. It is supplied by the cervical branch of the facial nerve.

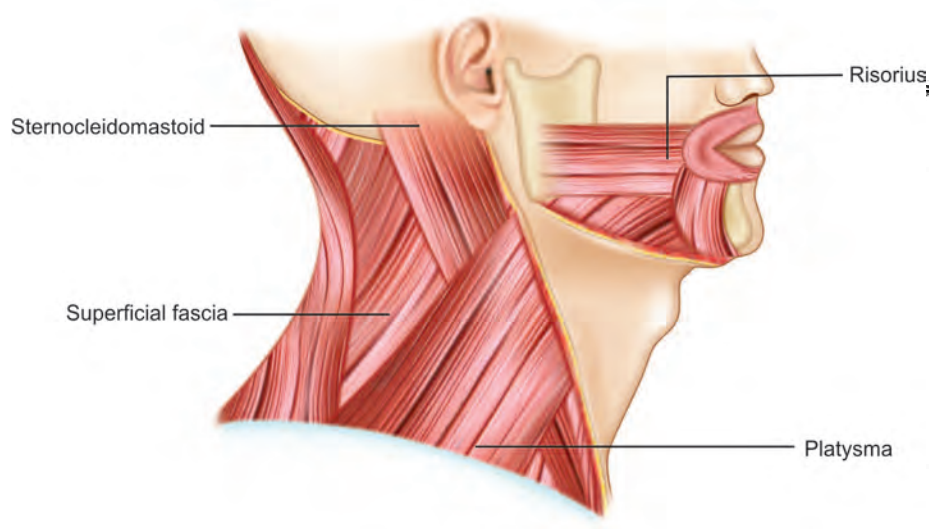


FIGURE 16 Platysma muscle—neck

Dissection: Carefully lift the platysma from the clavicle and reflect it towards the sternocleidomastoid muscle, it can be reflected fully in a later dissection. Identify the cutaneous structures.

CUTANEOUS STRUCTURES (Fig. 17)

External jugular vein: Locate this vein on the sternocleidomastoid muscle and trace it till it pierces through the deep fascia, posterior to the sternocleidomastoid muscle. It receives suprascapular and transverse cervical veins.

Cutaneous nerves: Trace the nerves along the posterior border of the sternocleidomastoid muscle. Note that the *supraclavicular nerves* descend down toward the clavicle, the *lesser occipital nerve* towards the scalp. The *great auricular nerve* crosses on to the sternocleidomastoid muscle to reach the external ear. The *transverse cervical nerve* runs across the sternocleidomastoid muscle.

The accessory nerve, (XIth cranial nerve) passes between the two layers of the investing layer of the cervical fascia. It loops with the lesser occipital nerve. This helps in identifying this nerve. You need to clean the fascia to locate this nerve.

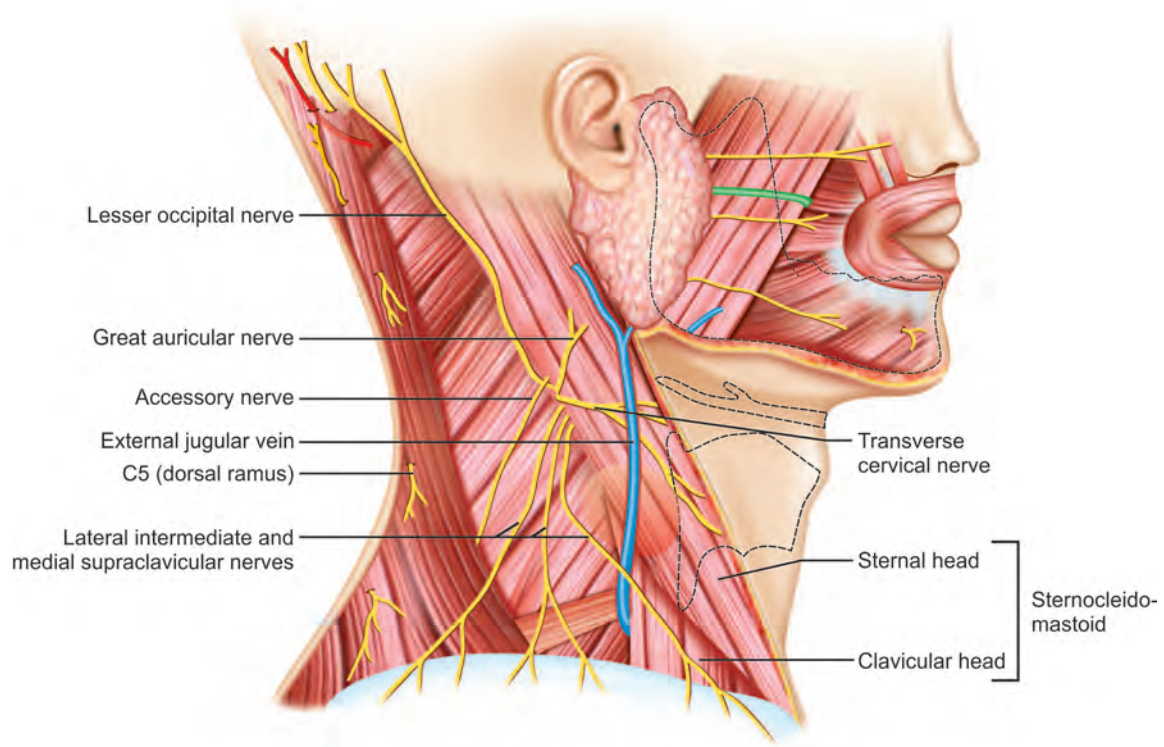


FIGURE 17 Cutaneous structures and deep fascia—neck

DEEP FASCIA—INVESTING LAYER OF CERVICAL FASCIA

The trapezius and sternocleidomastoid belong to the superficial group of musculature. Both these muscles are enclosed in the investing layer of cervical fascia. The fascia extends from the ligamentum nuchae, encloses the trapezius, then the two layers unite along its anterior border to form the roof

of the posterior triangle, encloses the sternocleidomastoid muscle covers the structures of the anterior triangle to be continuous with the fascia of the opposite side.

Dissection: Clean the fascia over the sternocleidomastoid and trapezius and the fascia between the two muscles, and study the muscles. Cut the supraclavicular nerves and remove.

Sternocleidomastoid: It is the key muscle in the neck region. It has a clavicular head and a sternal head. Look for the origin of the clavicular head from the superior border and anterior surface of the medial 1/3 of the clavicle. Here it has a muscular origin. The sternal head arises from the anterior surface of the manubrium sternum. Both the origins soon join to form a thick muscle mass, which extends posteriorly to be inserted. Locate its insertion into the mastoid process along a curved line.

Action: Look at this muscle extending from the front to the back of the neck. It pulls the mastoid processes downwards, thus results in lifting the face upwards. When muscle of one side acts it will pull the mastoid forwards thus turning the face to the opposite side.

BACK OF THE NECK SKIN INCISIONS (Fig. 18)

Dissection: Turn the body to a prone position. (1) Make a midline incision from the external occipital protuberance to the 7th cervical spine. If you are using the same body throughout for dissection, then the lower part is already dissected. Reflect the skin from the back of the neck, while doing so make sure that you are not damaging the trapezius muscle.

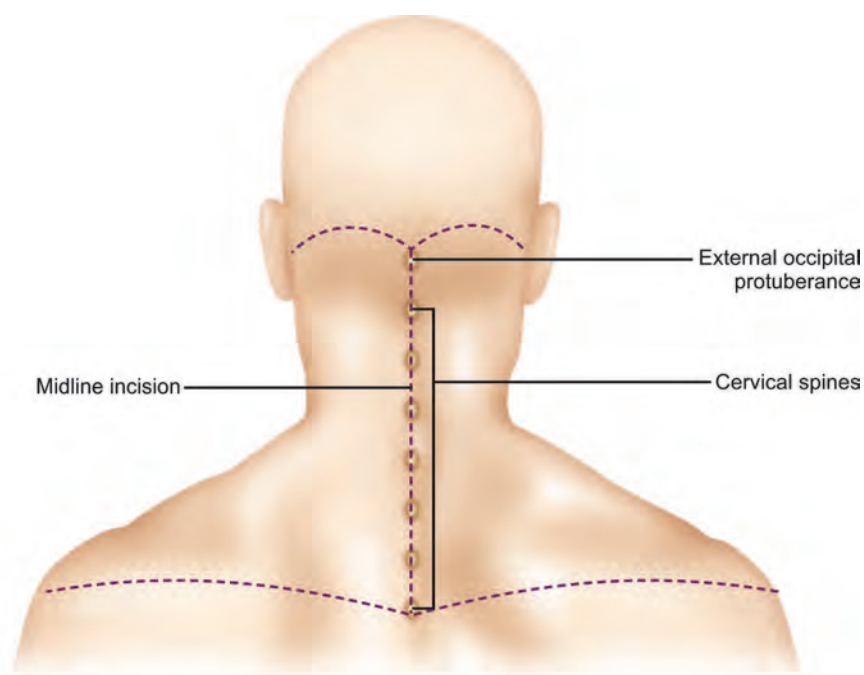


FIGURE 18 Incision lines and Surface anatomy—back of neck

SUPERFICIAL FASCIA and CUTANEOUS STRUCTURES (Fig. 19)

Superficial fascia and cutaneous structures: Here superficial fascia has lot of connective tissue, so feels tough, and it is filled with fine fat.

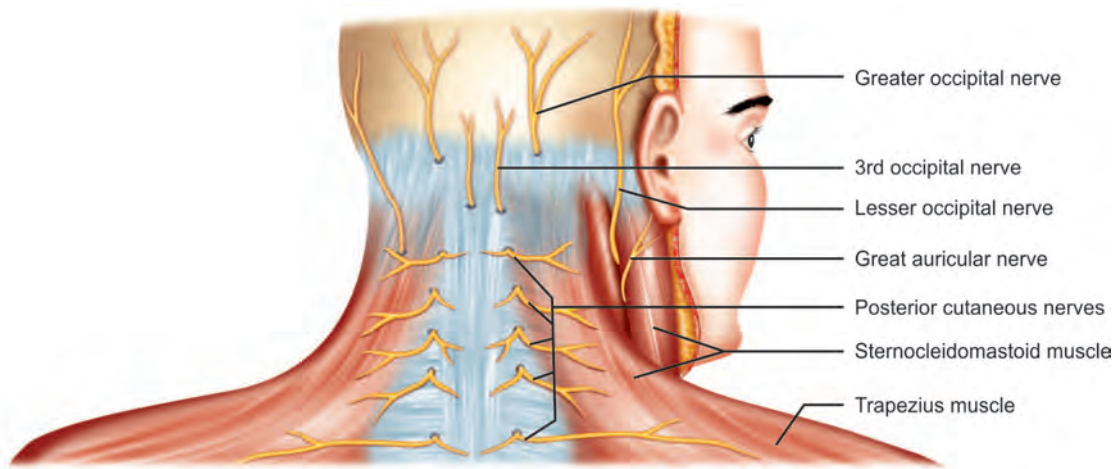


FIGURE 19 Cutaneous structures—back of neck

Greater occipital nerve: This nerve is already identified in the scalp region, trace it down, between the trapezius and sternocleidomastoid. Note the occipital artery accompanying this.

Third occipital nerve (C3): This nerve pierces lateral to the 3rd cervical spine. If possible locate this. The other posterior cutaneous nerves from 4th to 8th also pierce in their respective positions lateral to the midline to supply the skin on the posterior aspect. They are small and do not bother to trace all of them.

Lesser occipital nerve: Trace this nerve along the posterior border of the sternocleidomastoid muscle.

Dissection: Clean the trapezius and define its boundaries.

Trapezius: This is a muscle of the upper limb. It attaches the upper limb to the trunk bones.

Origin: It extends from the external occipital protuberance to the last thoracic spine in the midline, (the thoracic part has already been dissected) and from the medial 1/3 of the superior nuchal line. Trace this part now.

Dissection (Fig. 20): Separate the remaining part of the trapezius from its origin from the superior nuchal line and the ligamentum nuchae. Trace the accessory nerve and cervical branches entering into the undersurface of the trapezius muscle. After tracing this you may remove the muscle totally as it is partly removed.

Now identify the muscles that lie deep to the trapezius. They form the posterolateral group of musculature. They constitute two groups—The erector spinae (extensors of spine) group and the lateral rotator group.

The occipital artery and the posterior rami of the cervical nerves supply this musculature. Try to see as much as you can. Try to reflect the muscles layer by layer.

Occipital artery: It is the artery of supply to this region. It gives off a superficial and a deep branch, which goes between the muscles to supply them. Trace these branches as you are reflecting the muscles.

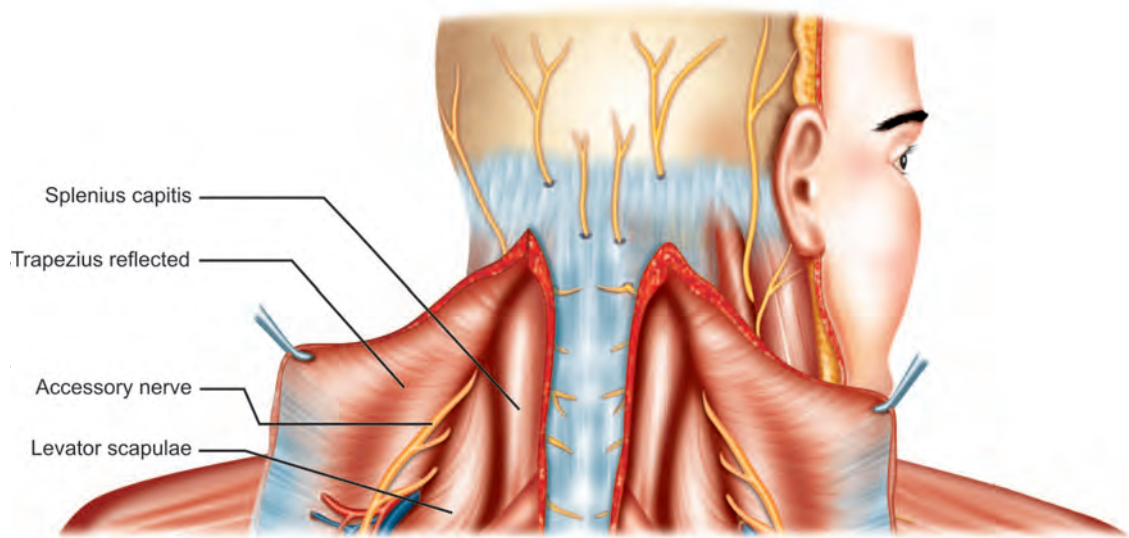


FIGURE 20 Deep surface of trapezius—back of neck

Motor nerves: The posterior rami of the upper cervical nerves give branches to supply the muscles of the back.

Splenius capitis (Fig. 21): Identify this muscle from the direction of its fibres. They extend from the midline to the lateral side.

Trace its origin from the lower part of the ligamentum nuchae and the upper six thoracic vertebral spines. Note its insertion into the superior nuchal line and mastoid process, deep to the sternocleidomastoid muscle.

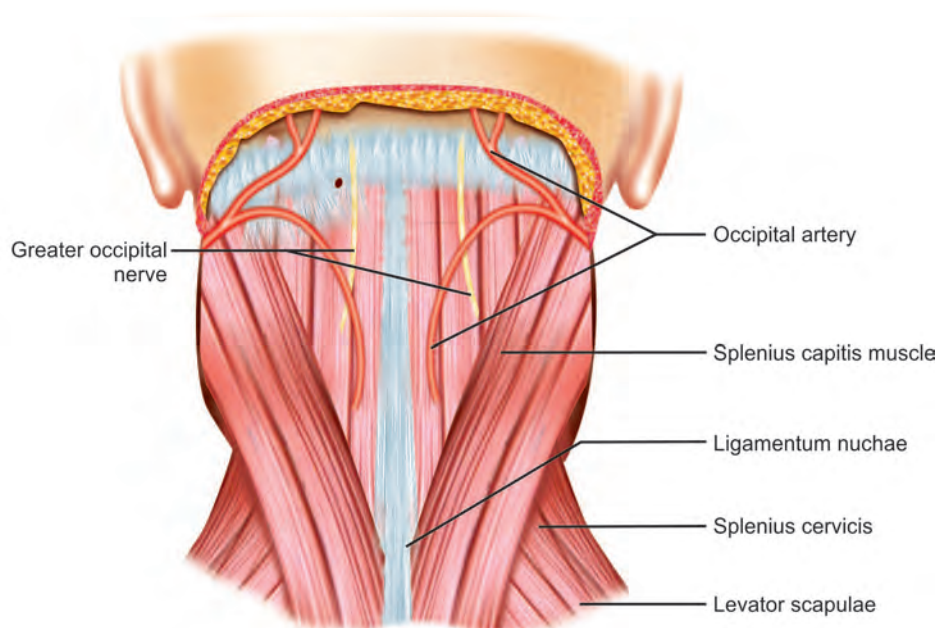


FIGURE 21 Splenius capitis and cervicis

Dissection: Lift the splenius capitis from its lateral side, and detach it from the skull. Reflect the muscle medially.

See the deeper **splenius cervicis** muscle. Its origin is same as the capitis but few of these fibres get inserted into the transverse process of the upper four cervical vertebrae. This is called the splenius cervicis.

Dissection: Detach this muscle from the transverse processes and reflect it medially to the midline taking care to preserve the cutaneous vessels and nerves already identified.

Semispinalis capitis (Fig. 22): This muscle fibres run opposite to the splenius capitis muscle. This muscle extends from lateral to medial side. It arises from the transverse process of upper six thoracic and lower four cervical vertebrae and is inserted into the medial aspect of the area between the superior and inferior nuchal lines.

Dissection: First trace the greater occipital nerve through the muscle and preserve it, then detach this muscle from its insertion and pull it towards the transverse processes.

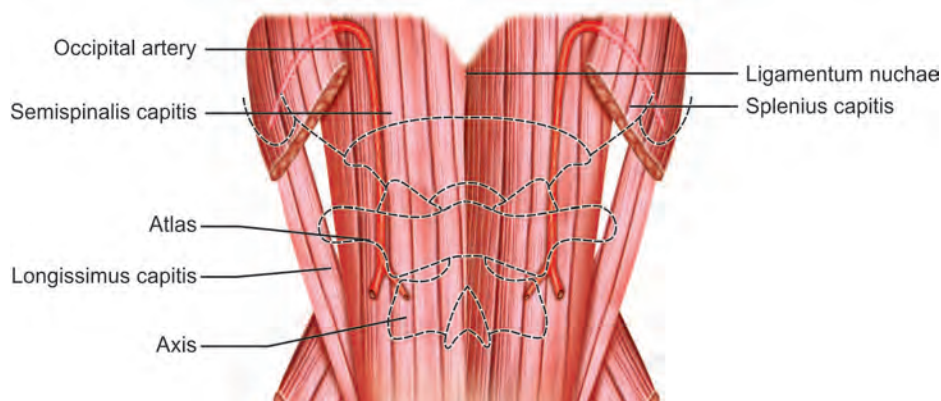


FIGURE 22 Semispinalis capitis and longissimus capitis

Longissimus capitis: Identify this muscle under cover of the splenius capitis. It extends from the upper thoracic transverse processes to be inserted into the mastoid process. Detach this muscle from the mastoid process to get a clearer view of the suboccipital triangle. The fibres which get inserted into the posterior aspect of the cervical transverse processes is called the longissimus cervicis muscle. You may identify these fibres.

Action of all the above muscles belonging to the superficial group of erector spine group of muscles perform extension of the cervical part of vertebral column.

Dissection: You may cut and remove all the above muscles to get a clear view of the deeper suboccipital triangle.

Ligamentum nuchae: Identify this midline thick ligament extending from the external occipital protuberance to the 7th cervical vertebra. This is a thick ligament made up of elastic fibres. With reflexion of the posterior muscles this ligament becomes visible. Appreciate its thickness and length.

The following muscles were cut in the upper limb dissection. Trace them to their origins. They are lateral rotators of the vertebral column.

Levator scapulae (Fig. 23): Note this lateral muscle. This arises from the transverse processes of the upper four cervical vertebrae. It is inserted into the medial border of the scapula above the spine (as the upper limb is already detached, note its lower cut end and confirm its insertion on scapula).

Scalenus medius: It is another lateral muscle. It arises from the posterior tubercles of the transverse processes of cervical vertebrae. It is inserted into the external surface on the middle of the first rib (confirm its insertion as a part of the first rib is still present with the trunk).

Inferior belly of omohyoid: It is an obliquely running muscle. It arises from the upper border of the scapula medial to the suprascapular notch (as the upper limb is detached it is cut but confirm it on the bone). It is inserted into the intermediate tendon which is under cover of the sternocleidomastoid (This will be studied in the anterior triangle).

The blood vessels and nerves forming the contents can be better traced in a later dissection.

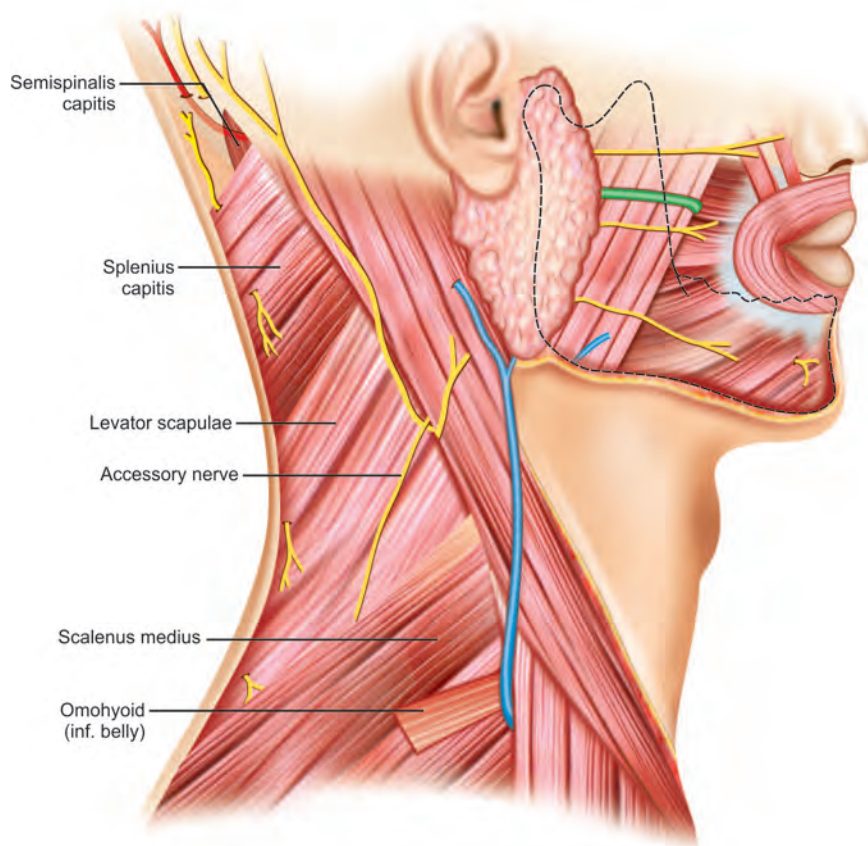


FIGURE 23 Muscles of posterior triangle floor—lateral aspect



SUBOCCIPITAL TRIANGLE (Fig. 24)

Suboccipital triangle is a muscular triangle made up of deep layer of erector spinae group of musculature.

The **roof** is formed of skin, superficial fascia, trapezius muscle, splenius capitis and semispinalis capitis muscle. These are the muscles you had already seen and reflected.

Dissection: Feel the posterior tubercle of atlas and the spine of the axis in the midline. Feel the arch and the transverse process of the atlas laterally. The muscles seen in the deeper layer are covered by connective tissue. Within this connective tissue look for the neurovascular bundle entering the muscles. The nerves are branches of 1st cervical posterior ramus. The arteries come from the occipital artery. The veins drain into the suboccipital plexus of veins. The veins fill this area. Now clean this area, remove the veins and trace the nerves entering the muscles. Identify the muscles.

The **medial boundary** is formed by two muscles.

Identify the bigger lateral muscle, the **rectus capitis posterior major**. It partly overlaps the medial rectus capitis posterior minor muscle. It arises from the spine of the axis and gets inserted into the area between the inferior nuchal line and the foramen magnum lateral to the rectus capitis posterior minor.

Dissection: Reflect this muscle from its insertion and identify the rectus capitis posterior minor.

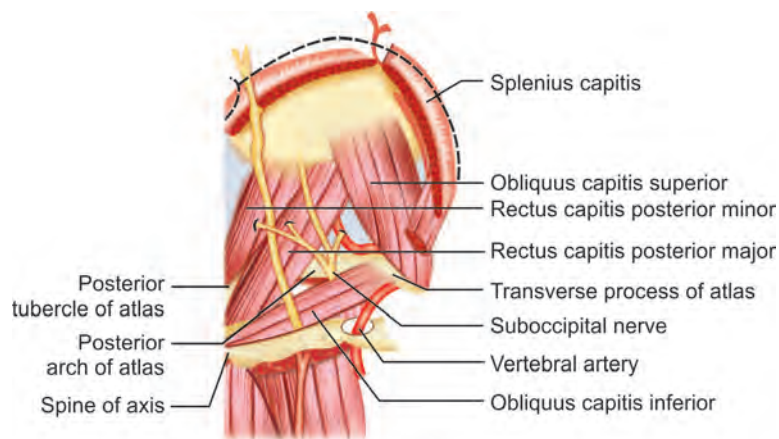


FIGURE 24 Suboccipital triangle—boundaries

Rectus capitis posterior minor: This is a small muscle on the medial side. It arises from the posterior tubercle of atlas and gets inserted into the area between the inferior nuchal line and foramen magnum.

Identify the **superolateral boundary**. It is formed by the **obliquus capitis superior**. It arises from the transverse process of atlas and is inserted into the area between the superior nuchal line and inferior nuchal line lateral to the insertion of semispinalis muscle.

Identify the ***obliquus capitis inferior***. This forms the inferior boundary. It arises from the spine of the axis and gets inserted into the transverse process of the axis.

Nerve supply of all the above muscles are supplied by the C1 posterior ramus—the suboccipital nerve.

Action: All the above muscles are rotators of the axis at the atlantoaxial joint. It is a pivot joint (see the bones, articulate them and perform the movements. Here the axis is the fixed part over which the atlas and the occiput rotates).

SUBOCCIPITAL TRIANGLE—FLOOR (Fig. 25)

Dissection: Reflect the obliquus capitis superior by detaching it from the insertion, and turn it down. Clean the area between the muscles. It is full of suboccipital plexus of veins. While doing so once again look for the nerves entering into the muscles.

Greater occipital nerve: Relocate this nerve and note that it emerges below the obliquus capitis inferior, pierces the semispinalis capitis to reach the scalp.

Suboccipital nerve: It is seen immediately above the posterior arch of atlas between it and the vertebral artery. It communicates with the greater occipital nerve and supplies all the suboccipital muscles.

Identify the structures forming the floor of the suboccipital triangle.

Feel the prominent ***posterior arch of atlas***. It is the bony prominence extending from right to left.

Vertebral artery: Identify this soft bulging artery extending from the foramen transversarium of the atlas to the foramen magnum.

Posterior atlanto-occipital membrane: Locate this medial to the vertebral artery. It extends from the posterior arch of atlas to the margin of the foramen magnum. Feel it, it is a resilient structure.

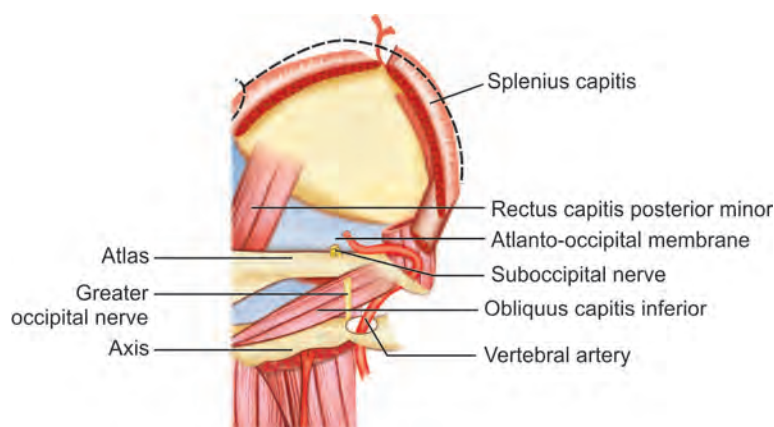


FIGURE 25 Suboccipital triangle—floor



ANTERIOR TRIANGLE

This is the area in front of the sternocleidomastoid to the midline. It extends superiorly from the mastoid process to the angle of the mandible, along the lower border of the mandible to the symphysis menti. Inferiorly it extends from the medial ends of the clavicle and the upper border of the manubrium sternum.

INCISION LINES (Fig. 26)

Dissection: Make a midline incision from the symphysis menti to the manubrium sterni. Reflect and remove this bit of the skin between the sternocleidomastoid and the midline. Skin here is very thin and the platysma is the subcutaneous muscle, start the reflection from the sternocleidomastoid side to the midline taking care to preserve the platysma.

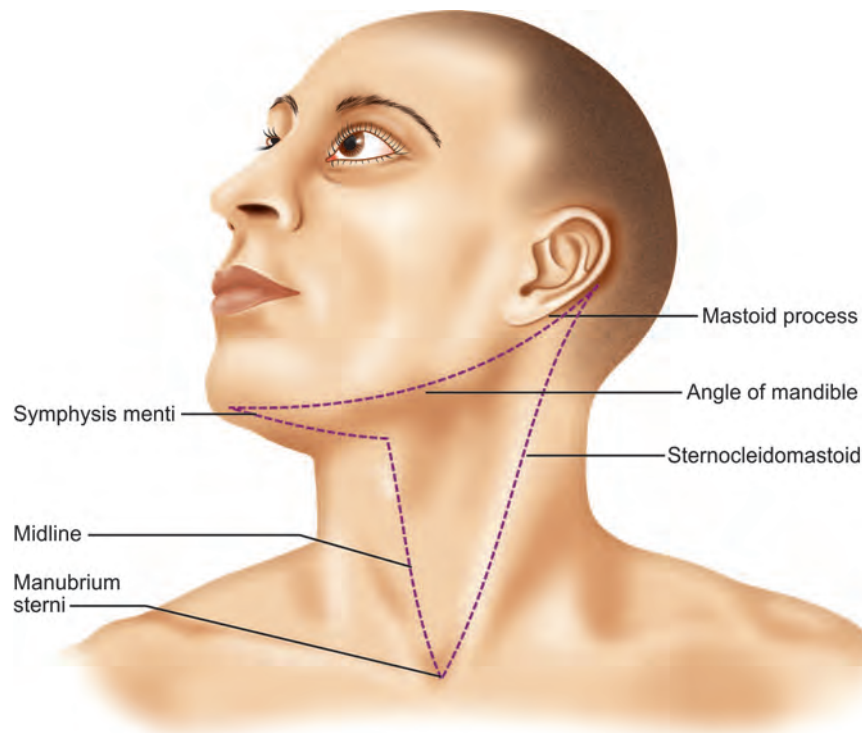


FIGURE 26 Incision lines—anterior triangle

PLATYSMA (Fig. 27): This is the subcutaneous muscle of the neck. It extends downwards and laterally from the lower border of the mandible, crosses over the clavicle to be inserted into the skin.

Dissection: Lift up this muscle from the lower border of the mandible.

Cervical branch of facial nerve: Look for this nerve on the undersurface of the muscle. It enters the muscle behind the angle of the mandible at the lower border of the parotid gland.

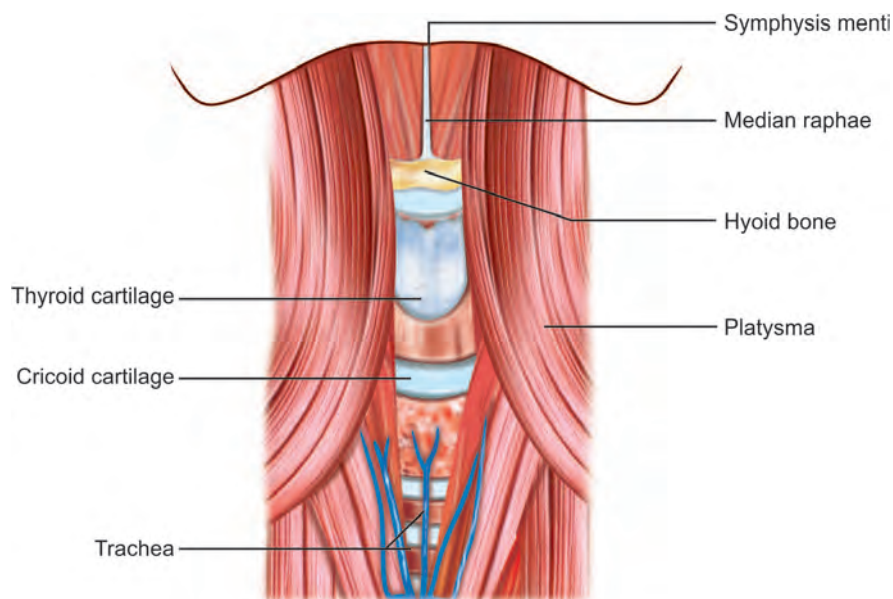


FIGURE 27 Platysma and midline structures

Identify the following structures in the midline.

The symphysis menti, median raphe, thyrohyoid membrane, anterior angle of thyroid cartilage (Adam's apple) cricotracheal membrane and upper tracheal rings.

CUTANEOUS STRUCTURES (Fig. 28)

External jugular vein: This was already identified at its lower end. Trace it up to its formation. It is formed by the union of posterior auricular vein and the posterior branch of the retromandibular vein. This is one of the superficial veins which can be easily accessed in the body.

Anterior jugular vein: Identify this thin vein lateral to the midline. It begins below and near the symphysis menti, runs down crosses laterally to enter into the external jugular vein.

Cutaneous Nerves

Great auricular nerve: Trace this nerve from the middle of the sternocleidomastoid to the ear lobule along the superficial surface of the sternocleidomastoid. It is a part of the cervical plexus and supplies the skin up to the angle of the mandible.

Transverse cervical nerve: Trace it from the middle of the sternocleidomastoid to the midline across the muscle.

Supraclavicular nerves: Trace these nerves from middle of the posterior border of the sternocleidomastoid to over the clavicle. They are generally three in number—the medial, intermediate and lateral branches. (These were already cut).

ANTERIOR TRIANGLE—SUBDIVISIONS (Fig. 29)

Dissection: Support the head on a block. Let the head fall back. Clean the structures in the anterior triangle and identify its subdivisions.

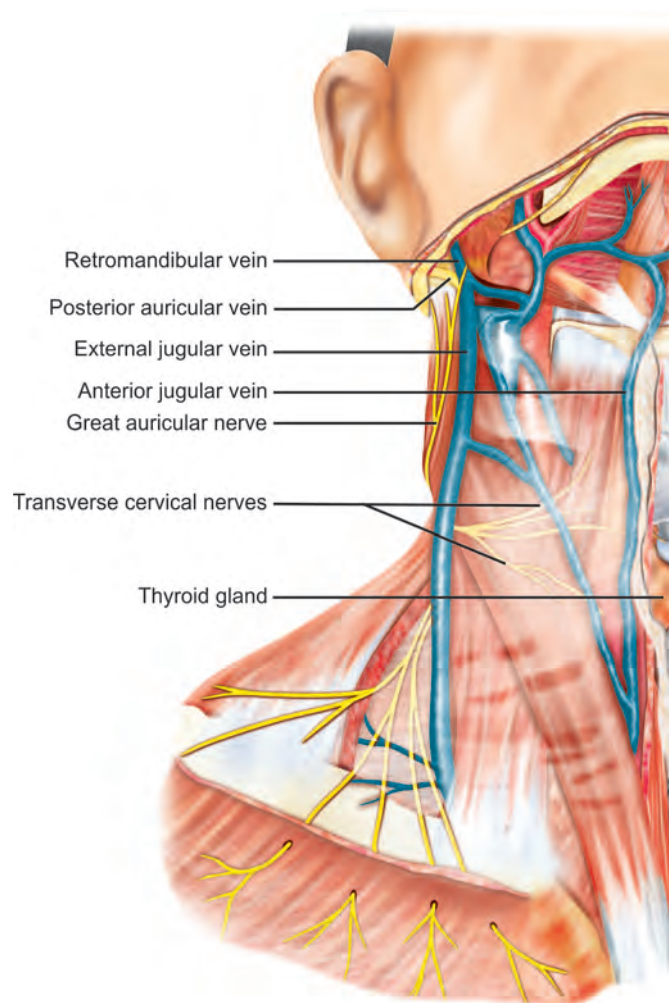


FIGURE 28 Cutaneous structures

The anterior triangle is the triangular area from the anterior border of the sternocleidomastoid, the lower border of the mandible and the midline. In this area, identify the anterior belly of digastric, posterior belly of digastric and the superior belly of omohyoid. These muscles are used to divide the anterior triangle into four smaller triangles for convenience of description. Study them.

1. **Submental triangle:** This is a midline triangle. Identify the body of the hyoid bone. This forms its base. Look for the anterior bellies of the digastric muscles. These form the limbs of the triangle.
2. **Submandibular triangle /digastric triangle:** Feel the lower border of the mandible. This forms the base of this triangle. Identify the anterior and posterior bellies of the digastric muscle. They form the sides of the triangle. See the prominent submandibular gland in this region.
3. **Muscular triangle:** Look at the muscles on either side of the midline below the hyoid bone. It is made up of two layers. The superficial layer is split vertically. The medial muscle is sternohyoid, and the lateral muscle is the superior belly of omohyoid (the deeper muscles can be seen in a later dissection).

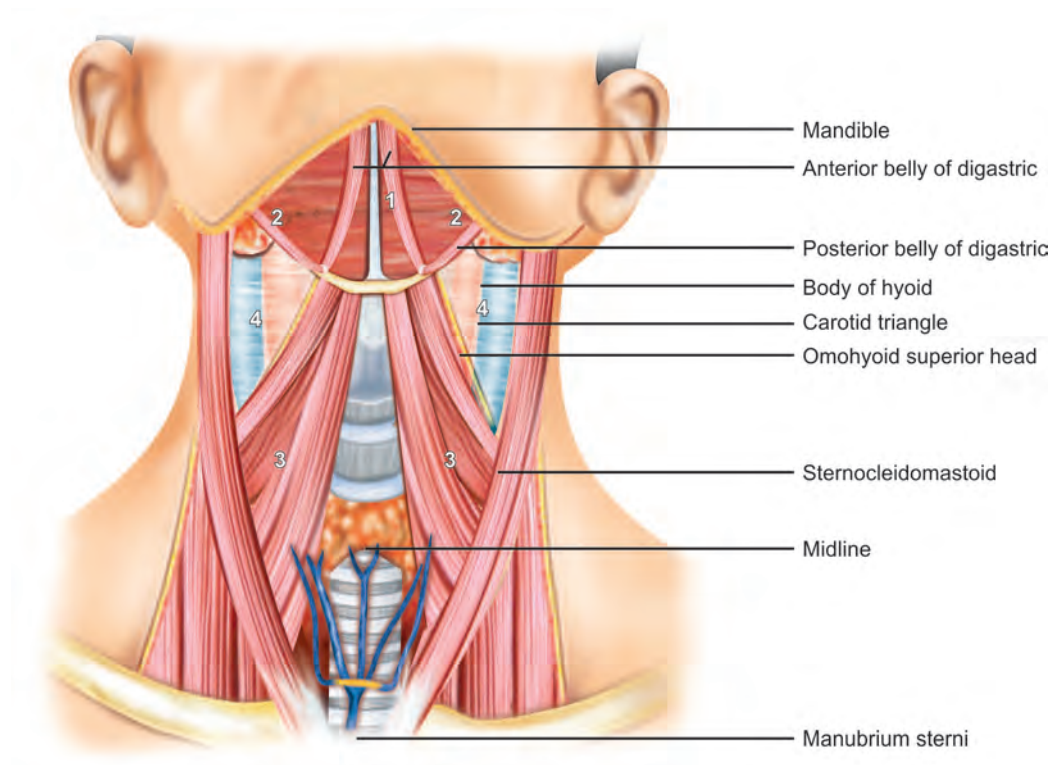


FIGURE 29 Anterior triangle—subdivisions

4. **Carotid triangle:** It is the lateral triangle. The base is formed by the anterior border of the sternocleidomastoid muscle. The limbs are formed by the posterior belly of digastric and superior belly of omohyoid. The neurovascular bundle of neck is located here.

Dissection: Cut and remove the cutaneous nerves and external jugular vein near the sternocleidomastoid muscle keeping their origins intact. Detach the muscle from the sternum and clavicle. In the upper half of the muscle look for the accessory nerve through the muscle and trace it to the point where it comes out of the carotid sheath near the angle of the mandible. You may slit the sternocleidomastoid muscle while locating the accessory nerve and remove it.



STERNOCLAVICULAR JOINT– DISARTICULATION

(Fig. 30)

Subclavius muscle: This was already studied while doing the upper limb dissection. Restudy this muscle. It arises from the 1st rib and costal cartilage, moves upward and laterally to be inserted into the undersurface of the clavicle in the subclavian groove.

Dissection: Detach this muscle from the undersurface of the clavicle, from the inferior side. This will preserve the nerve supply to the muscle.

Sternoclavicular Joint

It is a joint of the pectoral girdle attaching it to the trunk skeleton. It is a plane synovial joint. The medial surface of the clavicle articulates with the upper facet on the manubrium sternum. It is covered by capsule on all sides and is thicker anteriorly.

Costoclavicular ligament: Locate this ligament on the undersurface of the medial end of the clavicle and the upper surface of the 1st costal cartilage.

Dissection: Cut through the capsule anteriorly and open the joint cavity and see the intraarticular disc. It is a thick fibrocartilagenous disc. The capsule is attached to its periphery. The cartilagenous disc is inferiorly attached to the first rib. Gliding and rotatory movements are feasible at this joint. Detach the clavicle by separating it near the joint.

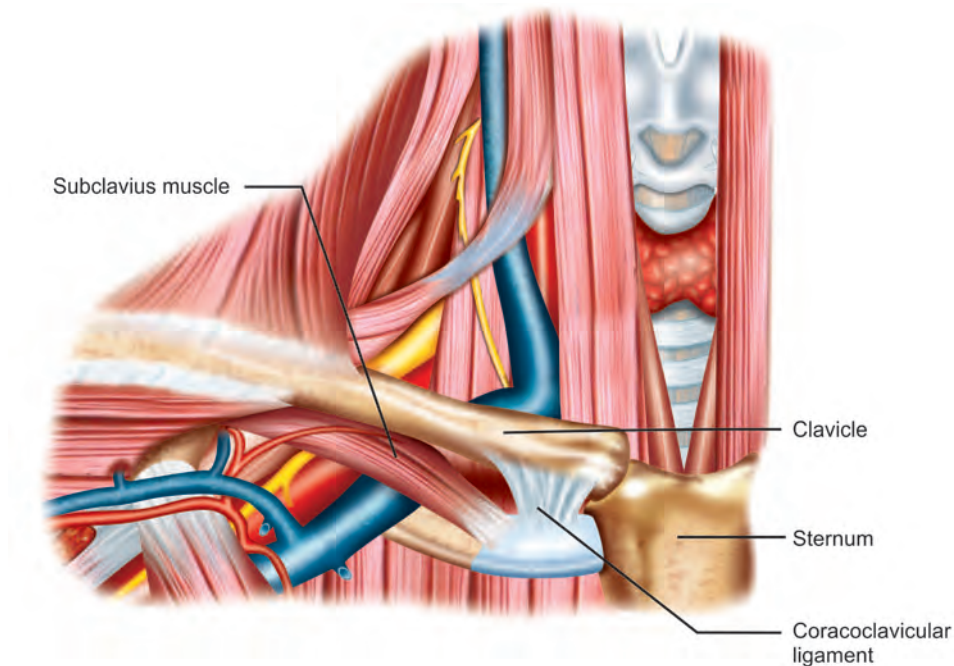


FIGURE 30 Sternoclavicular joint and subclavius muscle



INLET OF THORAX (Fig. 31)

The inlet of thorax is formed by the 1st thoracic vertebra, the 1st rib and the upper border of manubrium sternum. The rib is obliquely placed. The upper border of the manubrium lies at the level of the lower border of the 2nd thoracic vertebra. The inlet is closed on either side by the suprapleural membrane covering the lung and pleura. The trachea, esophagus and the neurovascular bundle passes in the midline between the two lungs. Due to the obliquity of the 1st rib all the structures passing between the thorax and the neck are exposed above the 1st rib, but they are covered by the positioning of the clavicle and subclavius muscle. The gap between the scapula, outer border of first rib and the clavicle is the apex of the axilla through which the neurovascular bundle reaches the upper limb (See the bony parts on a skeleton).

Suprapleural membrane/Sibson's fascia/scalenus minimus: This is the fascia covering the pleura. Locate its extent. This is the scalenus minimus muscle which is totally replaced by membrane. It arises from the tip of the transverse process of the 7th cervical vertebra and is inserted into the inner border of the first rib. Feel this from both thorax side and neck side. Clear this fascia to see the continuity of the structures from the thorax.

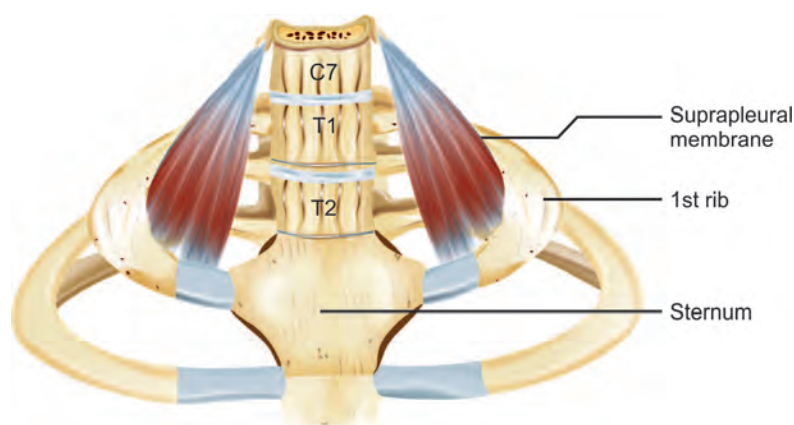


FIGURE 31 Inlet of thorax

MUSCULAR TRIANGLE

STUDY OF MUSCLES (Fig. 32)

Here the muscles are arranged in two layers—a superficial sternohyoid and omohyoid and a deeper sternothyroid and thyrohyoid muscles.

Omohyoid muscle: It arises from the body and the greater horn of the hyoid bone. Note a thick sling of connective tissue that connects the intermediate tendon to the back of the clavicle. Lift up this muscle and look for the nerve supplying the bellies on their undersurface. They are supplied by branches of the ansa cervicalis.

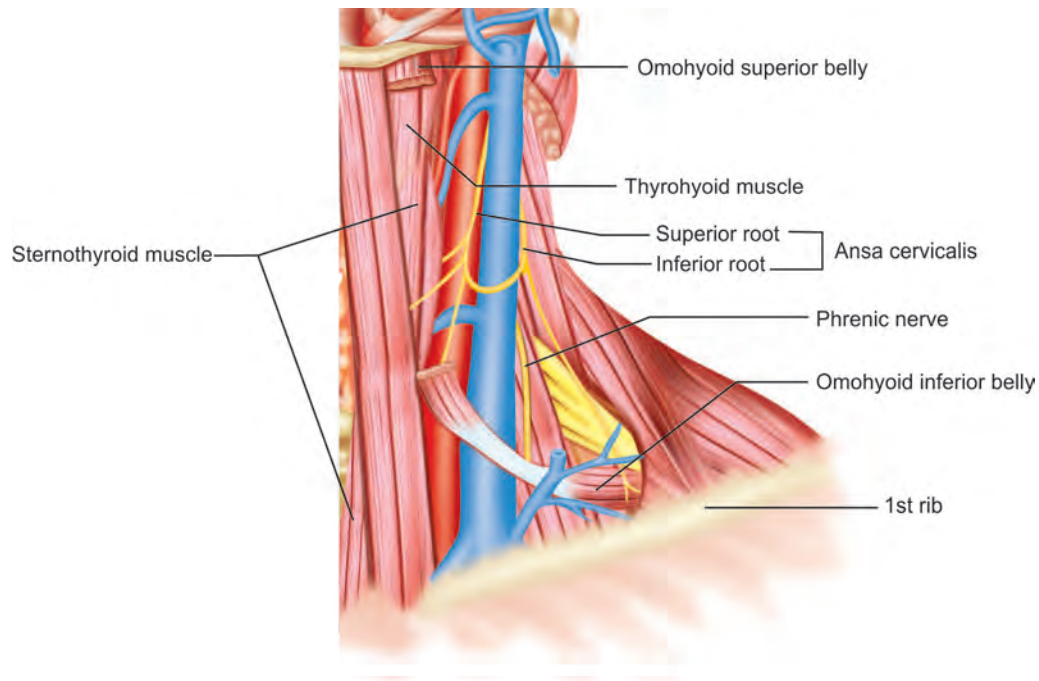


FIGURE 32 Muscular triangle and ansa cervicalis

Sternohyoid: Note this muscle medial to the omohyoid. It arises from the back of the manubrium sternum and is inserted into the lower border of the body of the hyoid. Trace the nerve of supply from the ansa cervicalis into this muscle.

Dissection: Cut the omohyoid superior belly transversely near its origin and reflect the muscle downwards.

Sternothyroid: Identify this muscle which lies deep to the sternohyoid muscle. It arises from the back of the manubrium sternum, below the origin of the sternohyoid. It is inserted into the oblique line of thyroid cartilage. It is supplied by a branch of the ansa cervicalis.

Actions: All the strap muscles depress the larynx.

Ansa Cervicalis

It is a nerve loop over the surfaces of the carotid sheath. Its loop supplies the strap muscles—omohyoid both the bellies, sternohyoid and sternothyroid muscles.

Dissection: Identify this nerve loop now. The nerve loop lies outside the carotid sheath in its wall. Put plenty of water over the carotid sheath. The connective yields and the nerves stand out.

Superior root of ansa cervicalis: Trace this limb between the internal jugular vein and the common carotid artery. Trace it superiorly and note that it is a branch of the hypoglossal nerve.

Inferior root of ansa cervicalis: Look for two branches winding round the internal jugular vein joining together and joining the superior root of ansa.

Ansa cervicalis is a part of the cervical plexus. It is contributed by C1, 2 and 3 ventral rami. The C1 fibres reach ansa through hypoglossal nerve and the C2 and 3 fibres wind round the internal jugular vein.

The loop formation is variable in its position. Branches to the strap muscles are given off from the loop.

Thyrohyoid muscle: This is also one among the muscles of muscular triangle. It arises from the oblique line on the thyroid cartilage and is inserted into the lower border of the greater cornu of the hyoid bone. It is supplied by C1 fibres through a branch of the hypoglossal nerve. It is an elevator of larynx. Trace the nerve into the muscle.



THYROID AND PARATHYROID (Figs 33 and 34)

Dissection: Cut and remove the sternohyoid and sternothyroid muscles. These form the superficial relation of the thyroid gland. The thyroid and parathyroid are connected to the trachea by pretracheal fascia. Clean the pretracheal fascia and see the thyroid and parathyroid glands. They are endocrine glands located in the midline in the lower part of neck. Identify this organ, see its parts and blood supply. The thyroid gland presents two lobes and an isthmus.

Lobes: Locate them on the sides. They are conical in shape. The upper pointed end extends up to the oblique line of thyroid cartilage. Inferiorly it is broader and extends up to the inlet of thorax. Each lobe presents a medial surface, anterior surface and a posterior surface.

Note: That the medial surface is related to the trachea and esophagus at its lower part, larynx and pharynx at its upper part. The posterior surface is related to carotid sheath. Anterior surface is overlapped by the strap muscles.

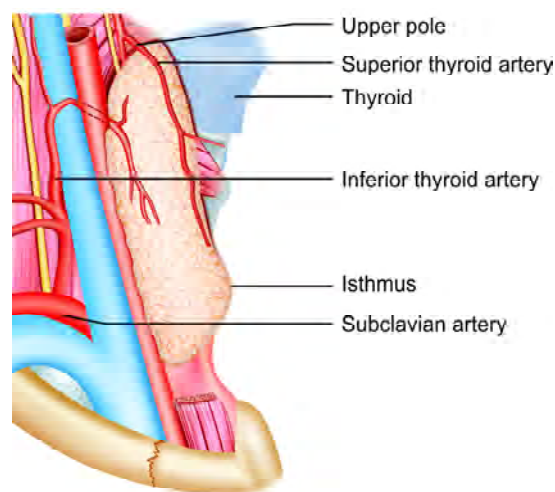


FIGURE 33 Thyroid gland

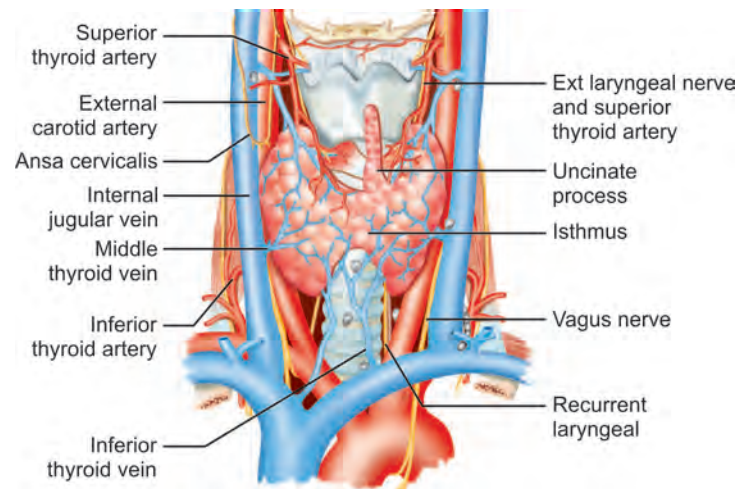


FIGURE 34 Thyroid gland—anterior view

The **isthmus** lies over the 2, 3, and 4th tracheal rings. Levator glandulae thyroideae is a small strip of the glandular tissue extends from the left side of the upper border of the isthmus to the hyoid bone. It is variable in size.

Blood Supply

Identify the superior thyroid artery at the upper pole of the gland. The **superior thyroid artery** divides into anterior and posterior branches, trace them as far as possible. The superior thyroid artery is accompanied by external laryngeal nerve. Trace it to the cricothyroid muscle. The **inferior thyroid artery** enters the lower pole of the thyroid. It arises from the 1st part of the subclavian artery. This branch supplies the inferior part of the thyroid gland. The **thyroidea ima artery** is a branch of the aorta and enters the lower border of the isthmus.

Veins: Generally there are three veins draining the thyroid lobes. The superior and middle thyroid veins drain into the internal jugular vein and the inferior thyroid vein drains the isthmus into the brachiocephalic vein. The **lymphatic drainage** accompanies the veins. Trace the recurrent laryngeal nerve which accompanies the inferior thyroid artery. The association of the nerve to the artery is to be taken care of during thyroid surgeries.

Dissection: Separate one half of the thyroid gland from the trachea take it out to see the way which is moulded to fit into the viscera. Study the posterior aspect and locate the parathyroid glands.

Parathyroid glands: Clean the connective capsule and locate the parathyroid glands. The superior parathyroid lies in the middle of the gland. The inferior parathyroid gland lies nearer to the inferior pole of the thyroid.



NEUROVASCULAR BUNDLE

The subclavian artery, its branches, the common carotid artery, the internal carotid artery, the external carotid artery and its branches form the arterial system in the neck. The anterior, external and internal jugular veins with their tributaries form the venous system. The 9th, 10th, 11th and 12th cranial nerves, the cervical and brachial plexus and the sympathetic chain form the nerves of the neck. Superficial and deep lymph nodes accompany these veins. The brachiocephalic trunk divides into common carotid artery and the subclavian artery on the right side whereas the common carotid and subclavian arteries arise independently from the arch of the aorta on the left side. Locate and trace these vessels from the thorax.

Carotid sheath: It is the thick fascial sheath which encloses the neurovascular bundle from the upper thorax to the base of the skull. It encloses the internal jugular vein and vagus nerve throughout its extent, the common carotid artery in the lower part and internal carotid artery in its upper part. It encloses the glossopharyngeal and the accessory nerve along with the vagus nerve in its upper part.

Dissection: Feel the internal jugular vein, the common carotid artery and the internal carotid artery. Clean the carotid sheath and expose the contents. Within the carotid triangle identify the internal jugular vein, internal carotid artery, the vagus nerve and the accessory nerve.

VEINS (Fig. 35)

Identify the major veins, the external jugular, subclavian, internal jugular and the brachiocephalic veins; if possible locate its tributaries.

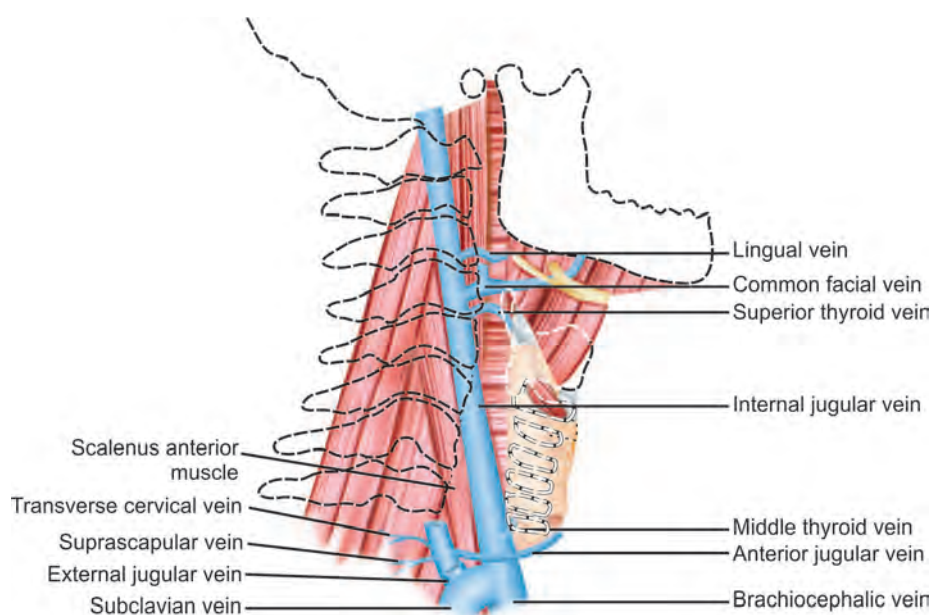


FIGURE 35 Veins of neck

External jugular vein: It lies superficial to the sternocleidomastoid and receives veins of the posterior region—the transverse cervical and the dorsal scapular. It receives the anterior jugular vein from the anterior aspect (already identified).

The subclavian vein: It extends from the outer border of the 1st rib to the inner aspect of the sternoclavicular joint, where it joins with the internal jugular vein to form the brachiocephalic vein. It receives external jugular veins.

Brachiocephalic vein: This descends down from the sternoclavicular joint to the 1st rib. It receives the veins accompanying the branch of the subclavian artery. It receives vertebral, inferior thyroid, internal thoracic and superior intercostals veins.

Thoracic duct: Locate this lymphatic duct on the left side. It is in front of the 7th cervical vertebra, crosses the subclavian artery and suprapleural membrane to reach the left brachiocephalic vein and empties into it (the thoracic duct the big lymphatic channel has already been identified in the thorax). Trace it up, to its termination.

Right lymphatic duct is a smaller channel. It opens into the right brachiocephalic vein near its formation.

Internal jugular vein: Identify this vein by cleaning the connective tissue of the carotid sheath. It enters the neck at the level of the jugular foramen. It descends down parallel to the carotid arteries. Try to locate its tributaries—the common facial vein, lingual vein, superior thyroid vein, the middle thyroid vein, the subclavian vein and the anterior jugular vein. Except the anterior jugular vein all the other veins accompany the corresponding arteries.

Dissection: Cut the subclavian vein, external jugular vein and the internal jugular vein. Remove them leaving a part of the brachiocephalic vein *in situ*.

SUBCLAVIAN TRIANGLE

The area between the middle 1/3rd of clavicle, inferior belly of omohyoid and posterior border of sternocleidomastoid muscle is the subclavian triangle. This lodges the subclavian vessels, brachial plexus and other nerves.

SUBCLAVIAN ARTERY (Fig. 36)

The subclavian artery is the artery of the upper limb. It leaves the thorax, crosses over the root of the neck to reach the axilla of the upper limb at the outer border of first rib. Trace the subclavian artery. Note its relation to the scalenus anterior muscle. Conventionally it is divided into three parts—1st part from the sternoclavicular joint to the medial border of the scalenus anterior, the second part—behind the scalenus anterior and the third part between the lateral border of the scalenus anterior to the outer border of 1st rib.

Dissection: Detach the scalenus anterior from the scalene tubercle, lift it up preserve the phrenic nerve which lies on the scalenus anterior muscle. Trace the branches of subclavian artery.

Vertebral artery: It is the first branch of the subclavian artery, arises from the anterior aspect, near the transverse process of the 7th cervical vertebra, lies between the scalenus anterior and longus colli and enters the foramen transversarium of the 6th cervical vertebrae.

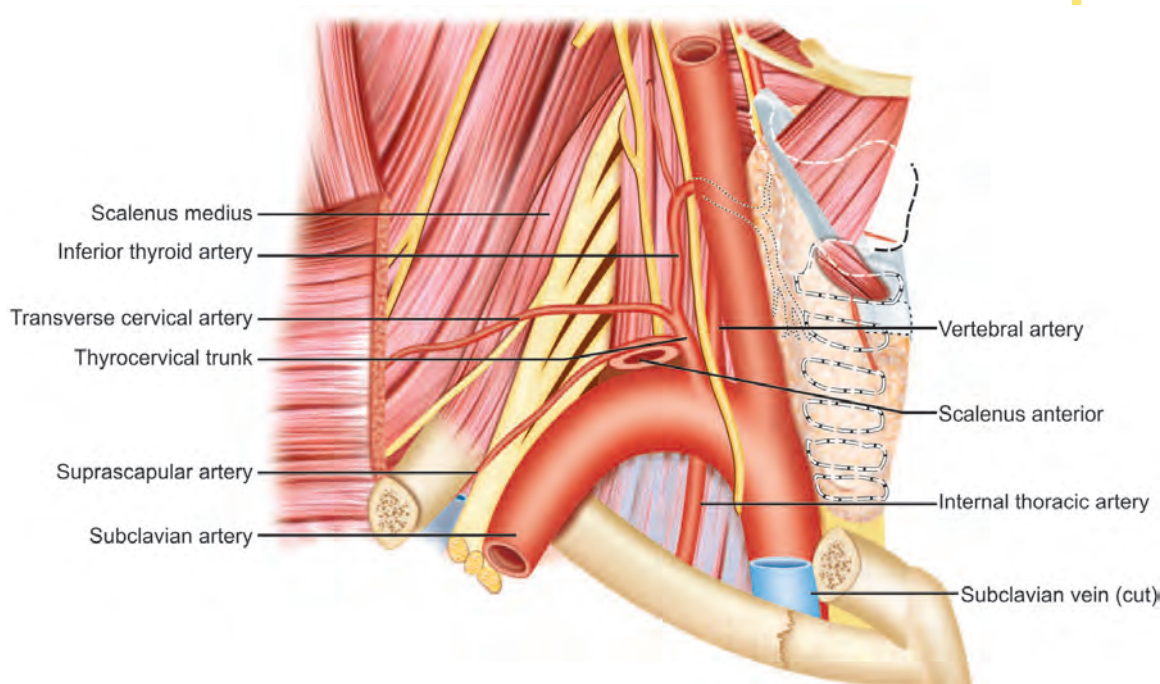


FIGURE 36 Subclavian artery

Thyrocervical trunk: It is the lateral branch from the superior aspect of the subclavian artery. It generally gives off three branches. The **inferior thyroid artery** turns medially to enter into the posteroinferior aspect of the thyroid gland. The **transverse cervical artery**—trace this artery across the scalenus anterior and the levator scapulae, there it divides into two branches, the superficial branch enters the deep aspect of the trapezius along with the accessory nerve and the deeper branch goes deeper to levator scapulae and rhomboidei along the medial border of the scapula. These branches were already studied in the dissection of the upper limb.

Internal thoracic artery: It arises from the inferior aspect of the subclavian artery crosses the suprapleural membrane reaches the posterior aspect of the sternoclavicular joint (its thoracic part was already dissected in thoracic).

From the second part of the subclavian artery: Locate this artery by pulling the artery forwards and look for its branches. The **superior intercostal artery** runs down close to the first two ribs and gives off branches into the intercostals spaces. The **deep cervical artery** ascends up in front of the scalenus anterior and transverse process of cervical vertebrae and gives off number of muscular branches.

The **third part of the subclavian artery** does not have any branches.

CAROTID ARTERIES (Fig. 37)

Dissection: Clean the carotid sheath and identify the artery at a superficial plane. Note that the common carotid artery divides into internal and external carotid artery opposite the upper border of thyroid cartilage.

Common carotid artery: On the right side it is a branch of the brachiocephalic trunk, on the left side it is a branch directly from the arch of the aorta. Trace it down to its origin.

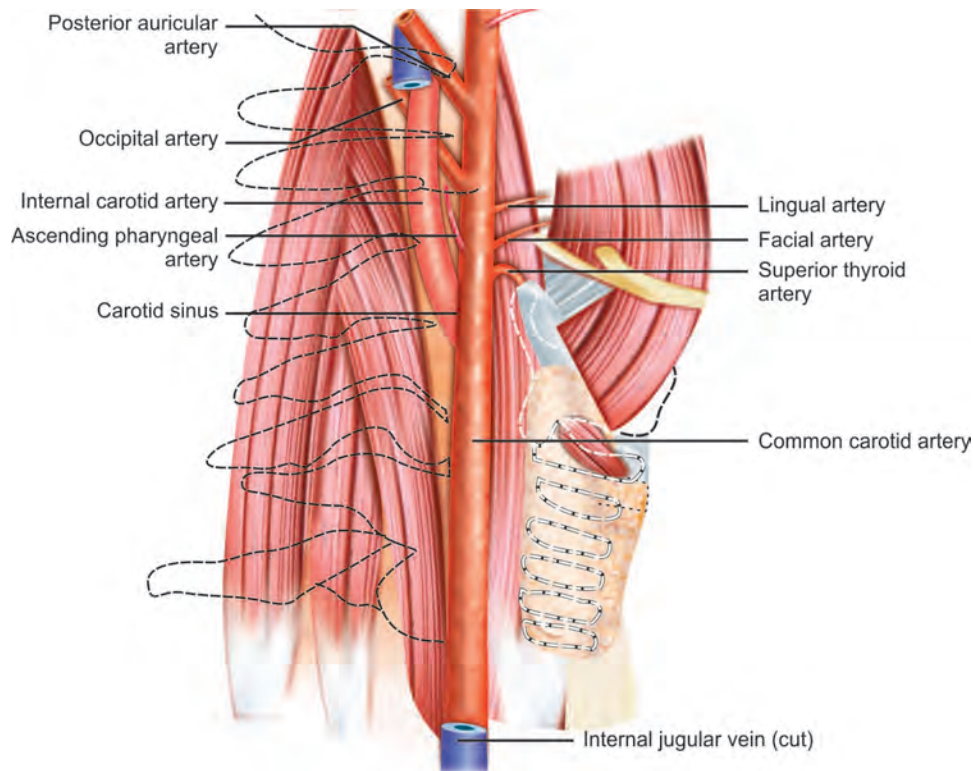


FIGURE 37 Carotid arteries

Carotid sinus: This is the enlarged upper end of the common carotid artery near its division. At this point the artery has got specialized nerve endings which act as baroreceptors.

Internal carotid artery: This is the artery which supplies brain. It ascends up to the carotid canal in the skull without giving any branch in the neck. It lies parallel and posterior to the external carotid artery. It lies within the carotid sheath throughout its extent.

External carotid artery: It is the artery of the neck and face. It gives off number of branches to supply these regions. Identify the following branches of the external carotid artery.

Dissection: Clean the connective tissue and identify the branches arising from the external carotid artery.

Superior thyroid artery: This is the first artery from the anterior surface of the *external carotid artery* above the level of superior horn of thyroid cartilage. Trace its branches—the infrahyoid branch which runs along the lower border of hyoid bone; the superior laryngeal artery which pierces the thyrohyoid membrane, the muscular branches to sternocleidomastoid and cricothyroid muscle; anterior and posterior thyroid branches near the apex of the thyroid gland.

Lingual artery: It is the next branch from the anterior aspect of the external carotid. It is given off at the level of the greater cornua of hyoid. It presents a looped appearance and disappears under cover of mylohyoid muscle. The branches of the artery can be seen at a later dissection.

Facial artery: Locate this artery immediately above the lingual artery. Trace this artery to the angle of mandible. There it gives off ascending palatine, tonsillar, glandular branches to submandibular

gland and submental branch which accompanies the mylohyoid nerve to supply anterior belly of digastric and mylohyoid muscle. Try to see these branches. Beyond this the artery is already traced in the face.

Occipital artery: Note this branch which is given off from the posterior aspect of the external carotid artery near the greater cornua of hyoid, opposite to the facial artery. Trace this artery to the mastoid process along the lower border of posterior belly of digastric muscle, and into the suboccipital triangle where it is already studied. It gives off muscular branches to sternocleidomastoid muscle, and meningeal branch to pass through the jugular foramen.

Posterior auricular artery: This is another artery given off from the posterior aspect. This runs towards the back of the ear along the upper border of the posterior belly of digastric muscle.

Ascending pharyngeal artery: Pull the external carotid artery laterally and look for a small branch of this artery, the ascending pharyngeal artery. It supplies the muscles of pharynx.

Superficial temporal and the maxillary arteries are the terminal branches of the external carotid and are seen in face dissection.

Dissection: Cut and remove the veins you can cut and remove the common carotid artery. Cut the branches of the external carotid artery near their emergence and remove the external carotid artery upto the angle of mandible. This gives a clearer view to visualize the nerves.

CRANIAL NERVES (Fig. 38)

9th, 10th, 11th and 12th cranial nerves, and all the cervical nerves forming the cervical and brachial plexus and sympathetic chain are located in the neck region. The cranial nerves are located in the

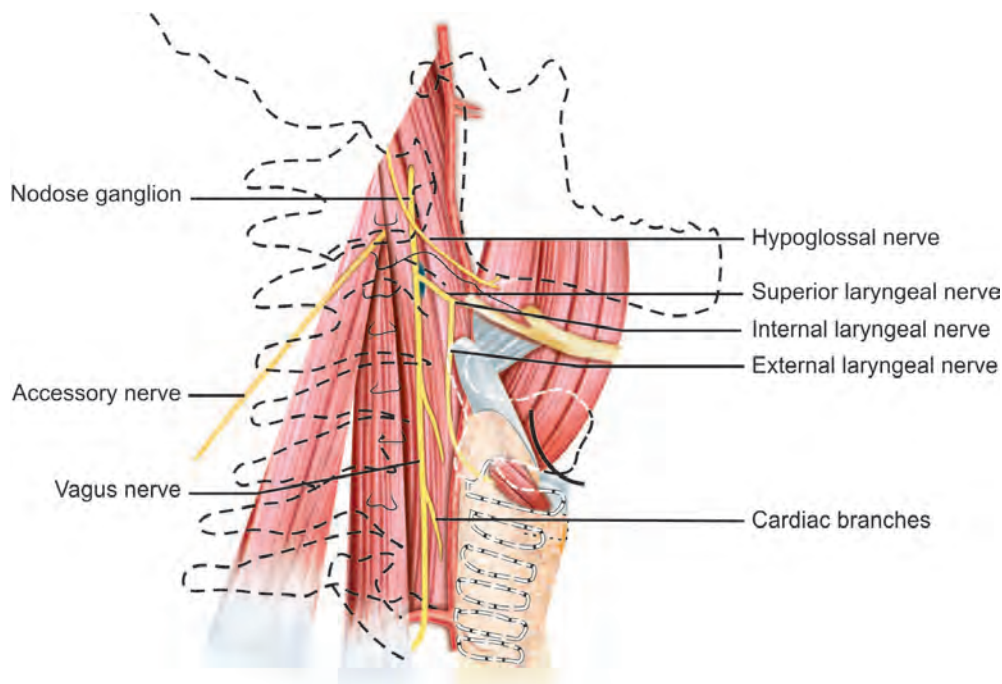


FIGURE 38 Cranial nerves

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carotid sheath along with the blood vessels. The spinal nerves lie between the scalenus anterior and scalenus medius muscles. The sympathetic chain lies in front of the transverse processes of the vertebrae. Try to locate them.

Hypoglossal nerve: It is the 12th cranial nerve. Locate this nerve between the internal jugular vein and internal carotid artery and inferior to the occipital artery. Trace it across the external carotid artery and crossing the lingual artery to enter deep to the mylohyoid muscle.

Accessory nerve: The 11th cranial nerve lies posterior and lateral to internal jugular vein. It enters the sternocleidomastoid near the posterior belly of digastric.

Vagus nerve: It is the 10th cranial nerve. Identify it in the interval between the internal jugular vein, internal and common carotid arteries. Trace it down into the thorax.

Superior laryngeal nerve is a branch of the vagus nerve. Locate this nerve deep to the carotid artery, trace it forwards. It accompanies the superior thyroid artery. The superior laryngeal nerve gives off the internal and external laryngeal nerves. Trace the internal laryngeal nerve along with the laryngeal branch of superior thyroid artery to the thyrohyoid membrane, the external laryngeal nerve runs down to supply the cricothyroid muscle.

Glossopharyngeal nerve: It is the 9th cranial nerve and will be seen at a later dissection.

SYMPATHETIC CHAIN AND SPINAL NERVES (Fig. 39)

Sympathetic trunk: Pull the carotid vessels medially with a hook and see the sympathetic chain in front of the transverse processes of the cervical vertebrae. Trace its total length. Look for the

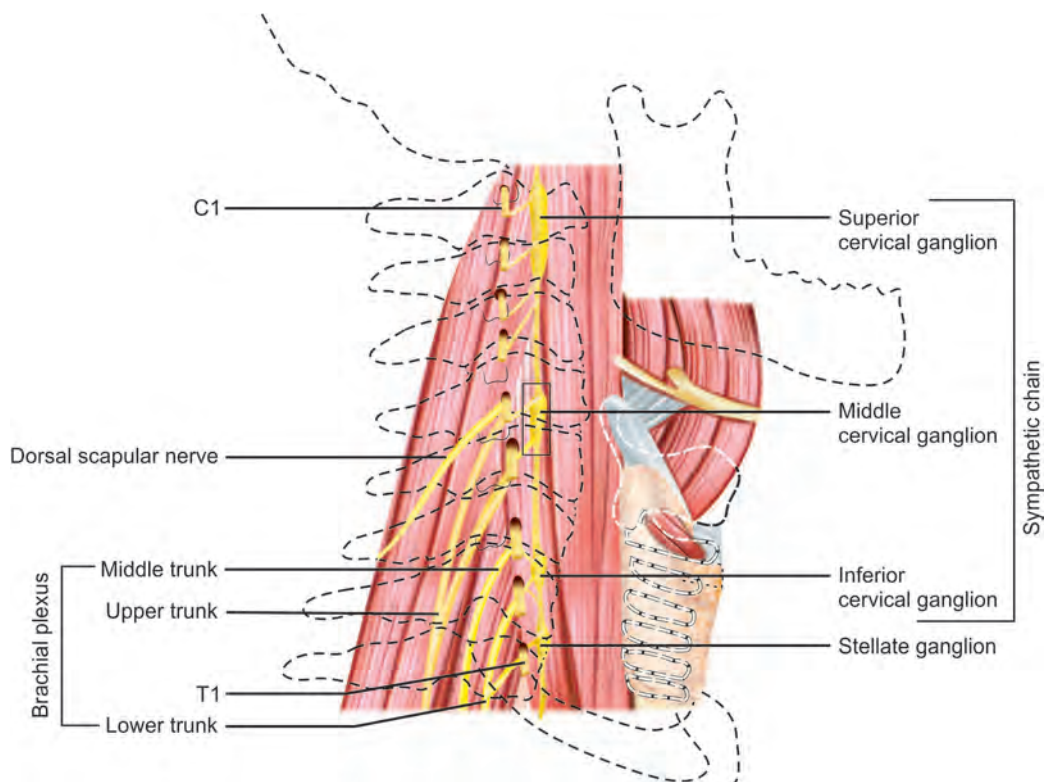


FIGURE 39 Sympathetic chain and spinal nerves

superior cervical ganglion in front of the 2nd and 3rd cervical vertebrae, the middle cervical ganglion near the 5th cervical vertebra and the inferior cervical ganglion near the neck of the first rib. The inferior cervical ganglion joins with the 1st thoracic nerve to form the stellate ganglion.

Ansa subclavia: Trace this loop between the middle and inferior cervical ganglia in front of the subclavian artery on the right side.

Gray rami communicantes: These connect the superior cervical ganglion to upper 4 cervical nerves, middle cervical ganglion to 5th and 6th cervical nerves and the inferior cervical ganglion to 7th, 8th cervical nerves, trace as many as possible.

Visceral branches are given off to pharynx, esophagus and heart. These are medial branches, trace as many as possible.

Vascular branches: These accompany the blood vessels, trace as many as you can.

Cervical ventral rami: Trace all the cervical nerves emerging between the vertebrae. They lie on the scalenus medius muscle.

All the cutaneous nerves, the great auricular, lesser occipital transverse cervical supraclavicular were already traced. Trace them to their origin from the cervical nerves and also trace the inferior root of ansa cervicalis to the C2, 3 roots.

Muscular branches: Trace these branches entering into the sternocleidomastoid, levator scapulae, scalenus anterior medius and posterior.

Brachial plexus: Trace the cervical 5,6,7,8 and T1 roots. Note that 5 and 6 join to form upper trunk, 7 forms middle trunk and C8, T1 form lower trunk. Trace these to the first rib. Note that the lower trunk lies deeper to the subclavian artery.

Long thoracic nerve/nerve to serratus anterior, dorsal scapular nerve/nerve to rhomboids, phrenic nerve to diaphragm— trace these nerves to the roots of brachial plexus.

Suprascapular nerve is given off from the upper trunk. It crosses in front of the scalenus medius deep to the omohyoid. It supplies the muscles on the posterior aspect of scapula.

Nerve to subclavius: It arises from the upper trunk. Trace it down across the subclavian artery to reach the upper surface of the subclavius muscle.

Phrenic nerve: Note this nerve on the anterior surface of the scalenus anterior muscle and trace it into thorax. This nerve supplies diaphragm and it has already been traced.

VERTEBRAL TRIANGLE (Fig. 40)

It is the area between the longus colli, 1st rib and scalenus anterior muscle.

Dissection: Cut the 1st rib near the scalenus anterior on either side and remove it with the sternum. Identify the continuations of the structures from the neck into the thorax. Trace the arch of the aorta and its branches, the brachiocephalic trunk, the left common carotid artery and the left subclavian artery. Trace the trachea and esophagus. Try to see the following nerves near the neck of the first rib.

Stellate ganglion: It is the inferior sympathetic ganglion. Identify this in front of the neck of the first rib. Note the ansa subclavian arising from here to connect this with the middle cervical sympathetic ganglion.

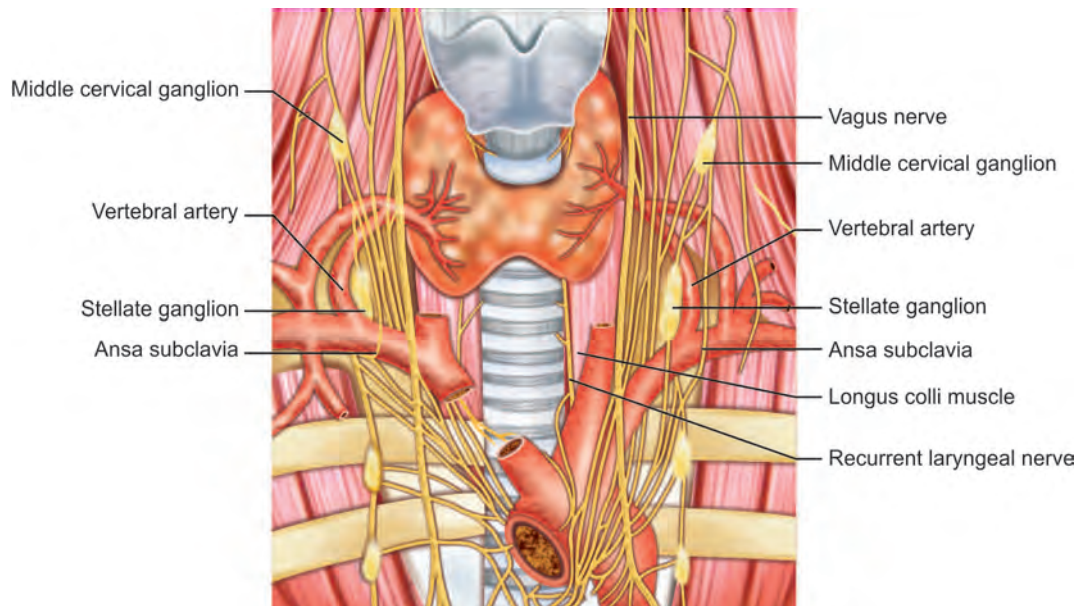


FIGURE 40 Vertebral triangle

Vertebral artery: See this arising from the superior aspect of the first part of the vertebral artery. Trace it into the 6th foramen transversarium.

First thoracic nerve: Trace this nerve to join the 8th cervical nerve to form the lower trunk of the brachial plexus.

Recurrent laryngeal nerve: Trace this nerve from the vagus and looping around the subclavian artery on the right side. On the left side it is given at a much higher level. Trace this nerve into the groove between the trachea and esophagus.

MUSCULATURE (Fig. 41)

Scalenus anterior muscle: Clean the scalenus anterior muscle. It arises from the transverse processes of 3rd to 6th cervical vertebrae. The three heads join together and descend down to reach the scalene tubercle on the inner border of the 1st rib. The muscle separates subclavian vein from the subclavian artery. Remove this muscle totally preserving the phrenic nerve. This muscle is already detached, trace it to its origin.

Scalenus medius: This muscle lies posterior to the brachial plexus. It arises from the posterior tubercles of the transverse processes of 2nd to 6th cervical vertebrae. The fibres join together to insert into the superior surface of the first rib, posterior to the groove for the subclavian artery.

Scalenus posterior: This is a small muscle arising from the 3rd to 6th posterior tubercles of the transverse processes and is inserted into the external surface of the middle of the second rib.

Ventral musculature: Try to identify the following musculature, after studying all the viscera.

Longus colli: It is the muscle on the ventral aspect of the vertebral column. Push the viscera medially and try to locate the muscle. It extends from the transverse processes to the bodies of the cervical vertebra and upper three thoracic vertebrae. Superiorly it reaches the anterior tubercle of atlas.

Nerves: These are all supplied by the segmental cervical nerves.

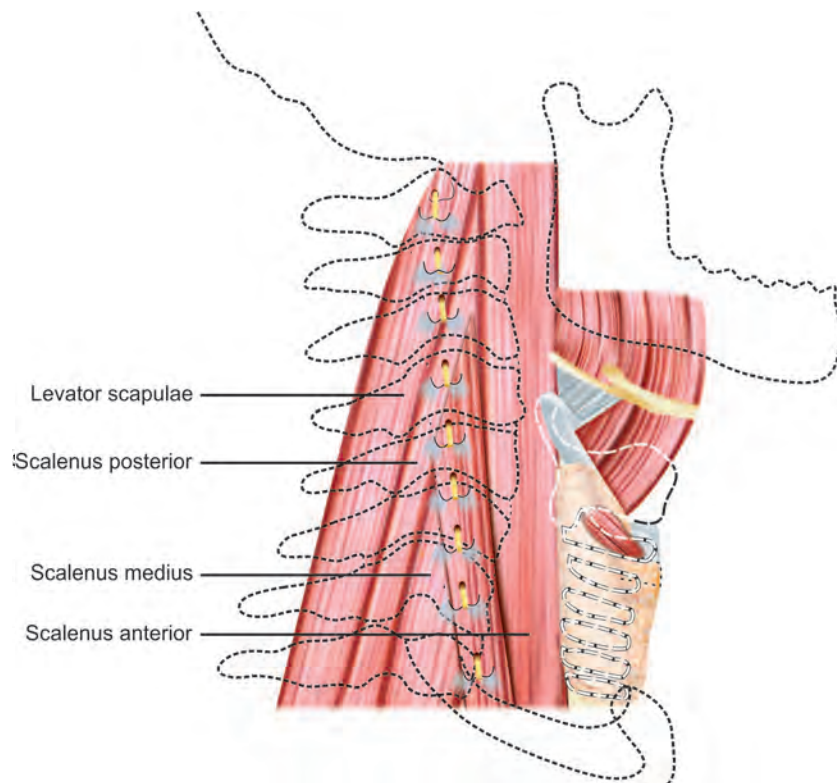


FIGURE 41 Lateral musculature

Action: All these muscles are flexors of the cervical vertebrae.

Rectus capitis anterior: This is a ventral muscle. Try to see this in a dissected specimen. It extends from the lateral mass of atlas, to the base of the skull in front of condyles. It is a flexor of the occiput.

Rectus capitis lateralis: It is an anterolateral muscle. It arises from the superior surface of the transverse process of atlas and gets inserted into the jugular process of the occipital bone. It is a lateral rotator. It is supplied by the ventral ramus of first cervical nerve. Trace this nerve between the above two muscle. It supplies both the muscles.



DIGASTRIC TRIANGLE (Fig. 42)

Stylohyoid muscle: Note this superficial muscle. It arises from the styloid process, lies superficial to the posterior belly of digastric, clasps the intermediate tendon of digastric to the hyoid bone. It is supplied by the facial nerve.

Dissection: Cut the tendon near the insertion, pull the muscle up, and look for its nerve supply.

Digastric muscle: It has got two bellies, it extends from mastoid process to the chin. Note the posterior belly near the angle of the mandible and trace it to its origin. It arises from a groove medial to the mastoid process. Note the anterior belly near the chin. It arises from the fossa on the undersurface of the mandible. Trace it down towards the insertion. The muscle is inserted by means of an intermediate tendon which is anchored to the greater cornu of hyoid bone by the stylohyoid tendon.

The above muscles are elevators of the hyoid bone. They help in deglutition.

Dissection: Detach the tendon from the sling and cut it. Separate the two bellies. Pull them towards their origins and look for their nerve supply entering into their undersurfaces. **Nerve to posterior belly of digastric**—pull the muscle laterally look for this nerve. It is given off from the posterior auricular branch of the facial nerve. **Nerve to the anterior belly of digastric.** Pull the muscle medially and look for the nerve near its origin. It is given off from the mylohyoid branch of the inferior alveolar nerve.

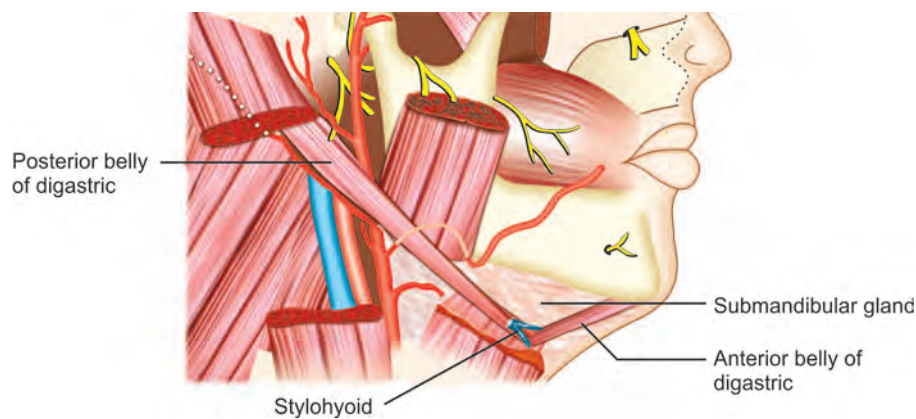


FIGURE 42 Digastric triangle

SUBMANDIBULAR GLAND (Fig. 43)

Submandibular gland: It is one of the salivary glands. What is seen between the two bellies of the digastric muscle is the superficial part of the gland. Note that it is occupying the space between the mandible laterally and the mylohyoid muscle medially. Note the submandibular fossa on a mandible, which is caused by this gland.

Dissection: Separate the gland from the neighboring structures. Look for its blood supply from the facial artery. With a scissors cut the gland near its posterior margin where it turns inside to become the deep part and remove the superficial part of the gland.

Mylohyoid muscle: Identify this muscle lying deep to the submandibular salivary gland and extending up to the midline. The mylohyoid muscle arises from the mylohyoid line on the inner aspect of the body of the mandible and is inserted into the upper border of body of the hyoid bone. In the midline it joins with the muscle of the opposite side and forms a raphae. It is supplied by the mylohyoid branch of the mandibular nerve. Press the muscle and look for the nerve entering into the lateral surface of the muscle. This supplies the anterior belly of digastric also. See both the branches. It is an elevator of larynx.

Look for the free posterior border of this muscle and identify the hypoglossal nerve and the deep part of the submandibular gland and its duct disappearing behind this border.

Hyoglossus muscle: Identify this muscle lying posterior and deeper to the mylohyoid muscle. The hyoglossus muscle arises from the greater cornua of the hyoid bone. The insertion of this muscle will be seen in the tongue dissection.

Lingual artery: Note this artery passing deep to the hyoglossus muscle.

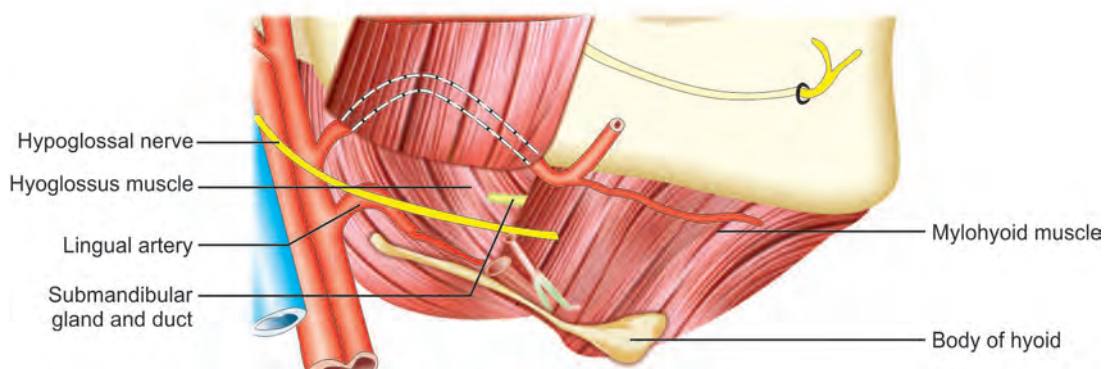


FIGURE 43 Submandibular region

DEEP DISSECTION OF HEAD



TEMPORAL AND INFRATEMPORAL REGIONS

The temporal fossa is the area over the squamous part of the temporal bone. Superiorly it is limited by the superior temporal lines. Inferiorly the temporal fossa is continuous with the infratemporal fossa.

The infratemporal fossa is the area between the pterygoid plates, base of the skull and the mandible (*Identify these on the skull*).

Temporal and infratemporal region are occupied by muscles of mastication. The temporomandibular joint lies surrounded by its muscles. The neurovascular bundle to supply this region is mandibular nerve and second part of maxillary artery.

Masseter muscle (Fig. 44): It is a thick muscle on the lateral aspect of the ramus of the mandible. It arises from the inferior margin and deep surface of the zygomatic arch. It is inserted into the lateral surface of the ramus. Note the direction of its fibres, they run downwards and posteriorly.

Action: It elevates, protracts and helps in side-to-side movement.

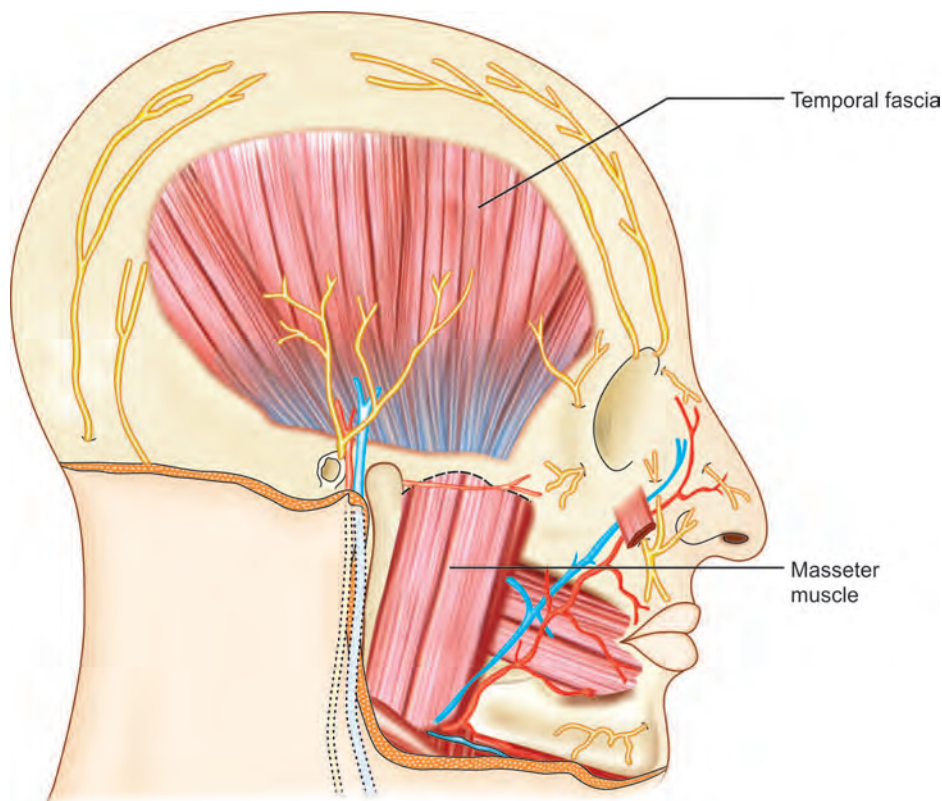


FIGURE 44 Masseter muscle and temporal fascia

Dissection: Cut through the zygomatic arch on either side of the origin of the masseter and reflect it downwards, while doing so locate the neurovascular bundle entering on its deep surface through the mandibular notch (Cut a bit of the muscle along with the neurovascular bundle for identification at a later date).

Temporal fascia: Study this thick fascia over the temporal fossa. It is attached to the superior temporal line (locate it on the skull) above and the upper border of the zygomatic arch below. Note that while removing the masseter this margin is cut, and the temporalis below this level is devoid of the fascia. The temporal fascia gives attachment to the temporalis muscle on its deeper aspect.

Temporalis muscle (Fig. 45): It is a fan-shaped muscle occupying the temporal fossa. The muscle arises from the temporal fossa up to the inferior temporal line and from the temporal fascia. Note its insertion into the coronoid process, along its anterior border and inner surface. Note the direction of the fibres. The posterior fibres traverse horizontally and the anterior fibres traverse vertically. The muscle is a retractor and an elevator.

Dissection: Saw and cut the coronoid process by an oblique cut and remove the lower part of the muscle to see the neurovascular bundle on its undersurface between the muscle and temporal bone. The arteries are two in number and are called deep temporal arteries. The nerves are temporal nerves and they arise from the anterior division of the mandibular nerve.

Stylomandibular ligament: Locate the styloid process and trace this ligament to the angle of the mandible. It is the deep part of the parotid fascia, acts as a sling to suspend mandible.

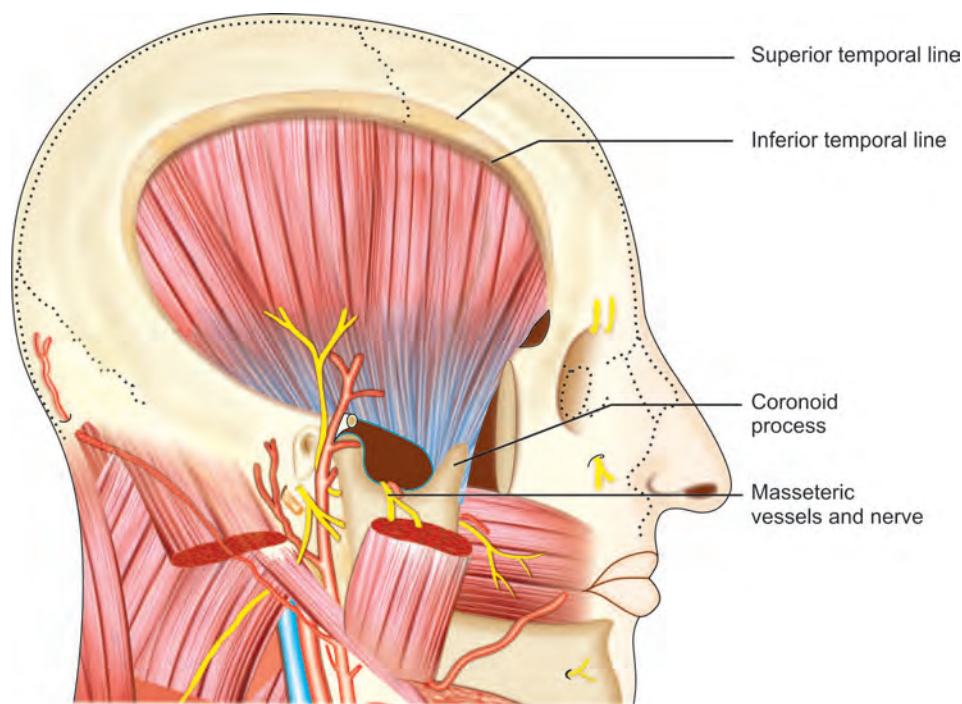


FIGURE 45 Temporalis muscle

INFRATEMPORAL REGION—SUPERFICIAL DISSECTION (Fig. 46)

Dissection: Remove the masseter totally and cut the ramus of the mandible by two cuts. The upper cut just below the neck of the mandible and a lower cut from the lower end of the anterior border of the mandible to the angle of the mandible. Remove the bone and clean and identify the structures seen in the fossa. While cutting put a forceps deep to the bone and take care of the nerves that lie deep. Let the cut go above lingula of mandible.

Maxillary artery second part: It is a superficial structure seen in here. It generally runs across the lateral pterygoid, or it goes deep, either below the inferior head or between the two heads of lateral pterygoid muscle. Locate the muscular branches to masseter, temporalis, pterygoid muscles and the buccal artery, accompanying the buccal branch of mandibular nerve.

The buccal branch of mandibular nerve is a sensory branch to supply the buccal pad of fat and the skin over the cheek. Locate this nerve passing between the two heads of lateral pterygoid to the cheek.

Lateral pterygoid muscle: This muscle occupies the upper part of the fossa. It arises by two heads, the upper head from the inferior surface of the greater wing of sphenoid, the lower head from the outer surface of the lateral pterygoid plate (confirm these parts on skull). The two bellies unite together to be inserted into the pterygoid fossa on the neck of the mandible. Note that its fibres ascend up from below, and run posteriorly from the front. It is a depressor, protractor and also helps in side to side movement. It is supplied by mandibular nerve on its deeper surface.

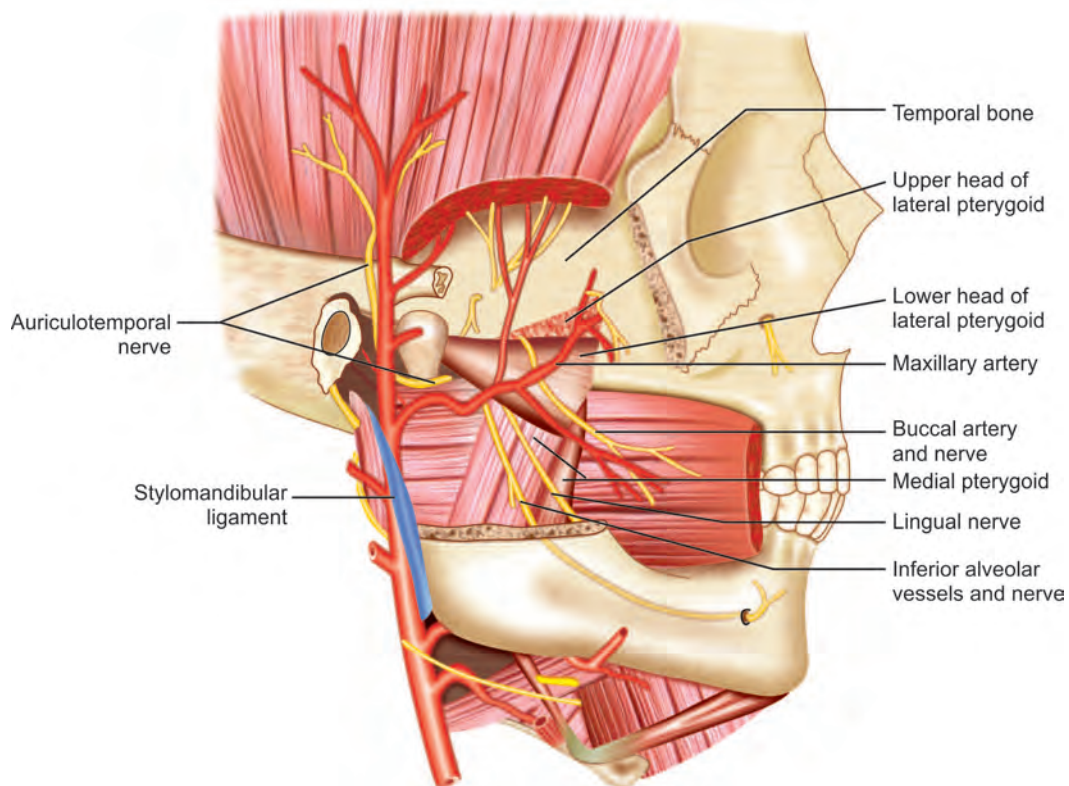


FIGURE 46 Infratemporal fossa—superficial dissection

Medial pterygoid muscle: This occupies the lower area of the infratemporal fossa. It has a superficial and a deep head. The superficial head arises from the maxillary tuberosity and the deep head arises from the medial aspect of the lateral pterygoid plate. These two heads soon unite and get inserted into the medial aspect of the angle and ramus of the mandible (see them on the skull). Note that the fibres run downwards, posteriorly and laterally. It is an elevator, protractor and helps in side to side movement. Nerve supply is given off from the trunk of the mandibular nerve. It enters the infratemporal fossa through the foramen ovale (locate this foramen on the skull). Locate this nerve near the base of the skull.

Mandibular nerve: It is a branch of the trigeminal nerve. It leaves cranial cavity through the foramen ovale. As soon as it enters the infratemporal fossa it gives off three branches from the trunk, and then divides into an anterior division and a posterior division. **The trunk** gives off the nervus spinosus, nerve to medial pterygoid, nerve to tensor tympani. **The anterior division** is predominantly a motor division except for buccal nerve which is a sensory branch. **The posterior division** is predominantly sensory nerve except for the motor branch to the mylohyoid muscle and the anterior belly of digastric.

The anterior division gives off the nerve to the masseter, lateral pterygoid, deep temporal nerves. Its sensory branch is the buccal branch. All these nerves are already identified. All of them were seen between the base of the skull and the lateral pterygoid muscle.

The posterior division gives off three branches, the lingual, buccal and the inferior alveolar nerves. Locate the lingual nerve which is a thick nerve and runs from the lower border of the lateral pterygoid muscle, in an anterior direction to reach the side of the tongue. Pull it forwards and locate the chorda tympani nerve joining it on its posterior side. The point of junction with the lingual nerve is variable. The lingual nerve carries general and taste sensations from the anterior 2/3rds of the tongue. Trace the **buccal nerve** which lies between the two heads of the lateral pterygoid to the buccal pad of fat on the buccinator muscle. Trace the **lingual nerve** extending from the lower border of the lateral pterygoid to the side of the tongue. Identify the **inferior alveolar nerve** which lies posterior to the lingual nerve. Trace this nerve to the mandibular foramen (Identify it on a dry mandible). This is the sensory nerve to the lower jaw, its terminal branch mental nerve has already been identified in face. Trace the mylohyoid nerve from the posterior aspect of the inferior alveolar nerve. It is motor to the mylohyoid and anterior belly of the digastric muscles.

Dissection: Remove the lateral pterygoid by cutting it nearer to its insertion. You may pull it out in pieces but make sure that the neurovascular bundle is not damaged. Trace the branches of mandibular nerve.

TEMPOROMANDIBULAR JOINT (Fig. 47)

This is the only synovial joint of the skull. The head of the mandible articulates with the mandibular fossa and the articular tubercle of the temporal bone. It is covered by fibrous capsule.

Lateral ligament: It extends from the articular tubercle on the zygomatic arch to the lateral aspect of the neck of the mandible.

Dissection: Cut through this ligament and look into the articular disc which separates the joint cavity into two parts. Note that the articular disc is continuous anteriorly with the tendon of the lateral pterygoid muscle. Cut the lateral ligament and see the capsule. Capsule is attached to both the proximal and distal bony parts.

Cut and remove the neck of the mandible with the articular disc.

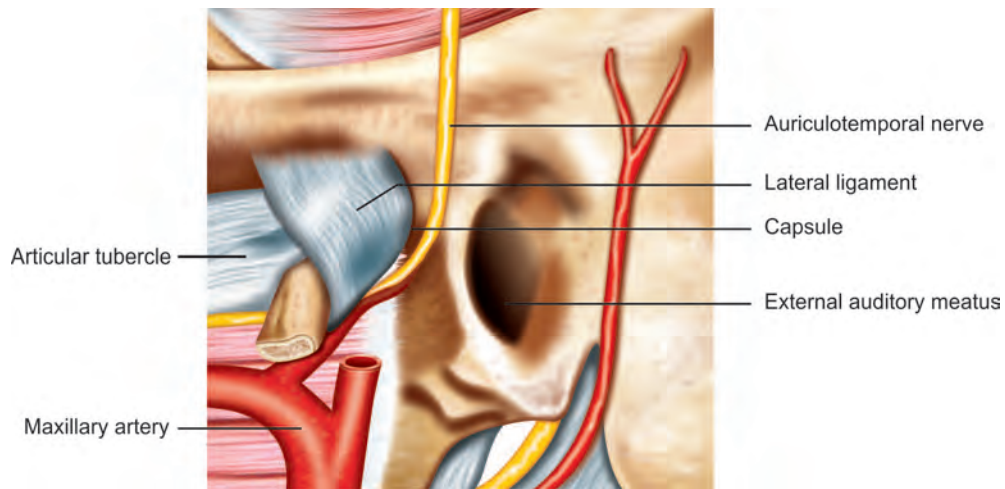


FIGURE 47 Temporomandibular joint—ligaments

The articular disc (Fig. 48) is a fibrocartilaginous structure. Look that its superior surface is concavo-convex and its inferior surface is convex.

Movements: Though it is uniaxial type of joint, it performs more movements because of the presence of articular disc. Protraction, retraction, elevation, depression and side to side movements are performed here.

Study the details from a Textbook.

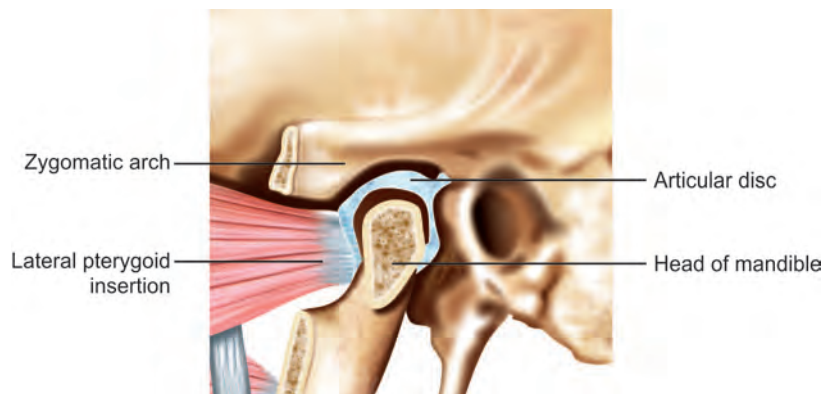


FIGURE 48 Temporomandibular joint—anterior

INFRATEMPORAL FOSSA—DEEP DISSECTION (Fig. 49)

Dissection: Cut the superficial temporal artery and remove it. Study and identify the structures seen here.

First part of the maxillary artery: Trace this artery from the external carotid artery. It is related to the neck of the mandible. It gives off five branches—auricular, anterior tympanic, accessory meningeal are fine branches. The middle meningeal artery is a bigger branch. Trace it up to the foramen spinosum. It is accompanied by the meningeal branch of the mandibular nerve. The inferior alveolar artery is another big branch. It descends down to the mandibular foramen. It enters the foramen along with the inferior alveolar nerve.

Sphenomandibular ligament: This is a thin sheet of connective tissue extending from the spine of the sphenoid (see it on the bone) to the lingula on the mandible.

Auriculotemporal nerve: It is given off from the posterior part of the posterior division of the mandibular nerve very near the skull. It generally splits into two, encloses the middle meningeal artery. It ascends posteriorly behind the neck of the mandible to supply the skin on the lateral aspect of the scalp (this has already been identified).

Otic ganglion is a parasympathetic ganglion connected to the mandibular nerve. Pull the posterior division forwards and locate this tiny ganglion with its spider like connections. It is at a deeper plane between the nerve to medial pterygoid and the tensor veli palatini.

Chorda tympani nerve: Identify this nerve joining the posterior aspect of the lingual nerve. It leaves the skull through the petrotympanic fissure (identify this on the skull) and its point of joining the lingual nerve is variable in position. The chorda tympani nerve is a branch of the facial nerve and it carries the secretomotor fibres to the submandibular and sublingual salivary glands and taste sensations from the anterior two thirds of the tongue.

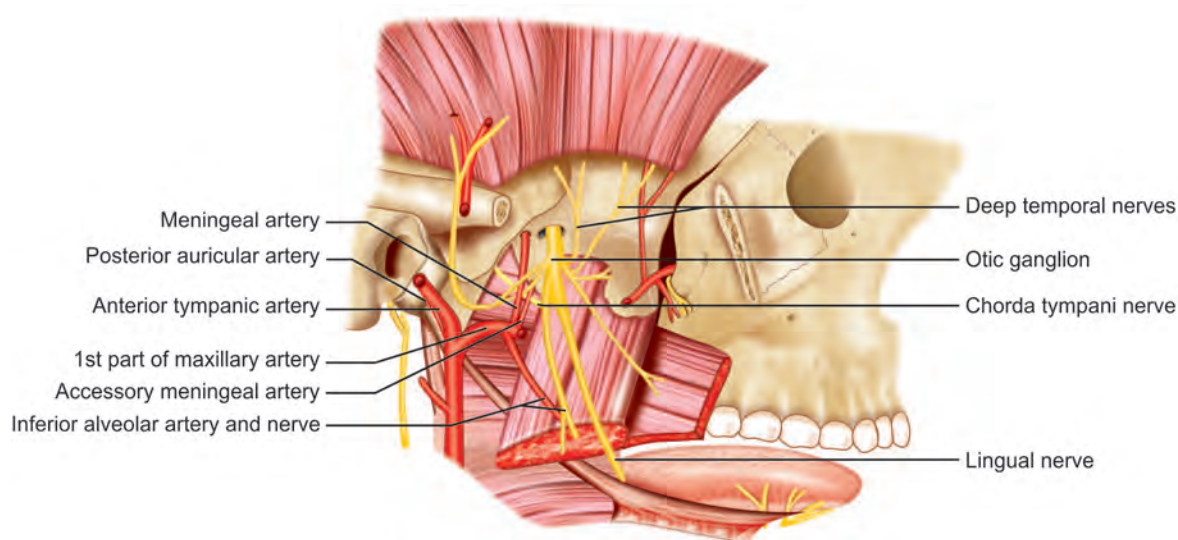


FIGURE 49 Infratemporal fossa—deep dissection

Dissection (Fig. 50): Chisel and chip the body of the mandible up to the point of the mental foramen. While doing this, separate the two tables of mandible, identify the inferior alveolar nerve. Remove the outer table up to the mental foramen. After seeing the inferior alveolar nerve, cut the mandible in the midline, cut the nerve near the mandibular foramen and remove the mandible. Detach the mylohyoid muscle from its origin from the mylohyoid line of the mandible. Reidentify the nerve supply from inferior alveolar nerve.

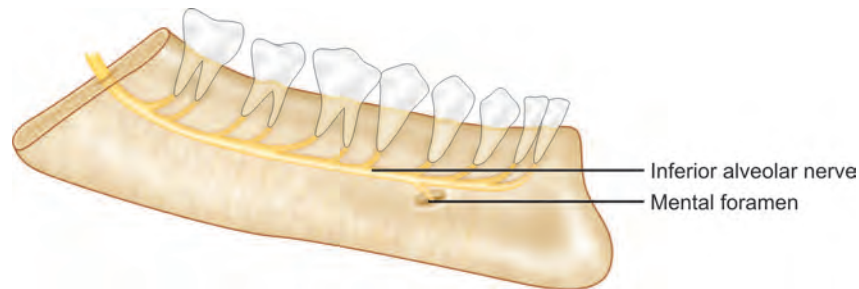


FIGURE 50 Inferior alveolar nerve

STYLOID APPARATUS (Fig. 51)

Dissection: Feel the styloid process lateral to the superior constrictor and identify the following.

Styloglossus muscle: Trace this muscle forwards and downwards to the area between the hyoglossus and mylohyoid muscle. This is one of the extrinsic muscles of the tongue. It arises from the anterior surface of the styloid process and is inserted into the lateral side of the tongue. It is a retractor of tongue.

Stylohyoid muscle: Trace this muscle from the posterior aspect of the styloid process to the hyoid bone. It arises from the posterior surface of the styloid process and at its insertion it splits into

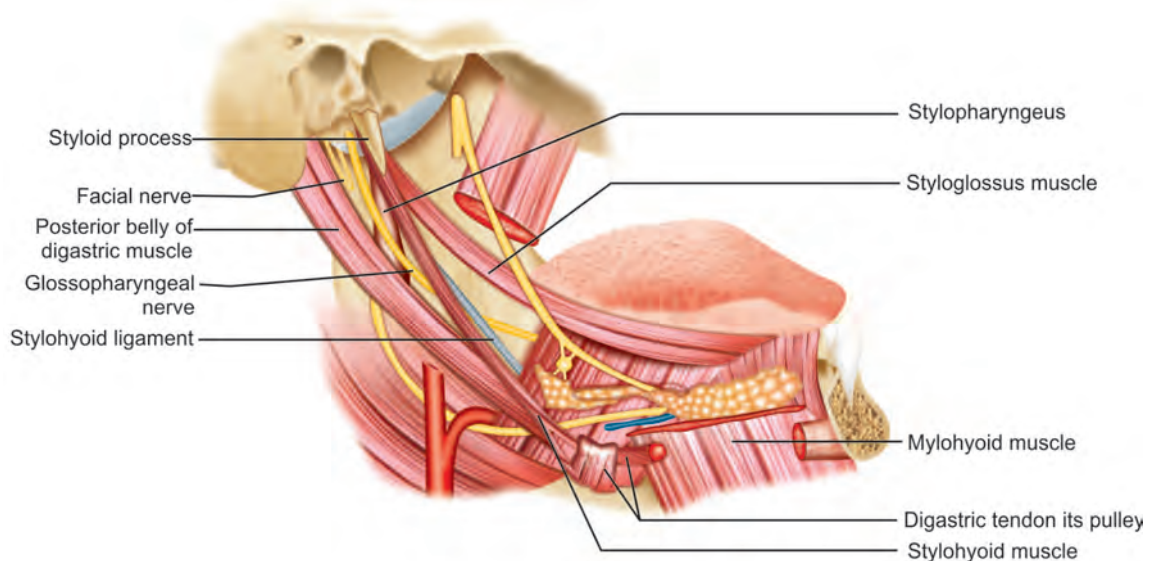


FIGURE 51 Styloid apparatus

two parts clasps the intermediate tendon of the digastric to the greater cornu of hyoid bone. It is an elevator of the hyoid bone. It is supplied by the posterior branch of the facial nerve (this muscle was already cut in the digastric triangle dissection).

Stylopharyngeus muscle: This is a muscle on the medial side of the styloid process. It arises from the medial surface of the styloid process and is inserted into the posterior border of the thyroid cartilage. It is another longitudinal muscle of the pharynx. It enters the pharynx between the superior and middle constrictor of pharynx.

Glossopharyngeal nerve: Locate this nerve winding round the stylopharyngeus muscle. This supplies the stylopharyngeus muscle. After it enters into the pharynx it is sensory to pharynx and posterior 1/3rd of tongue.

Stylohyoid ligament: Locate this thin ligament extending from the tip of the styloid process to the lesser cornua of the hyoid bone. It is internal to the stylohyoid muscle.

Facial nerve: Note the cut part of this nerve at stylomastoid foramen.



SUBMANDIBULAR REGION (Fig. 52)

Dissection: Cut the mylohyoid muscle near the hyoid bone. Identify the hyoglossus muscle and the structures on the hyoglossus muscle.

Hyoglossus muscle: It is an extrinsic muscle of the tongue. It arises from the greater horn and body of the hyoid bone. It is inserted into the lateral side of the tongue.

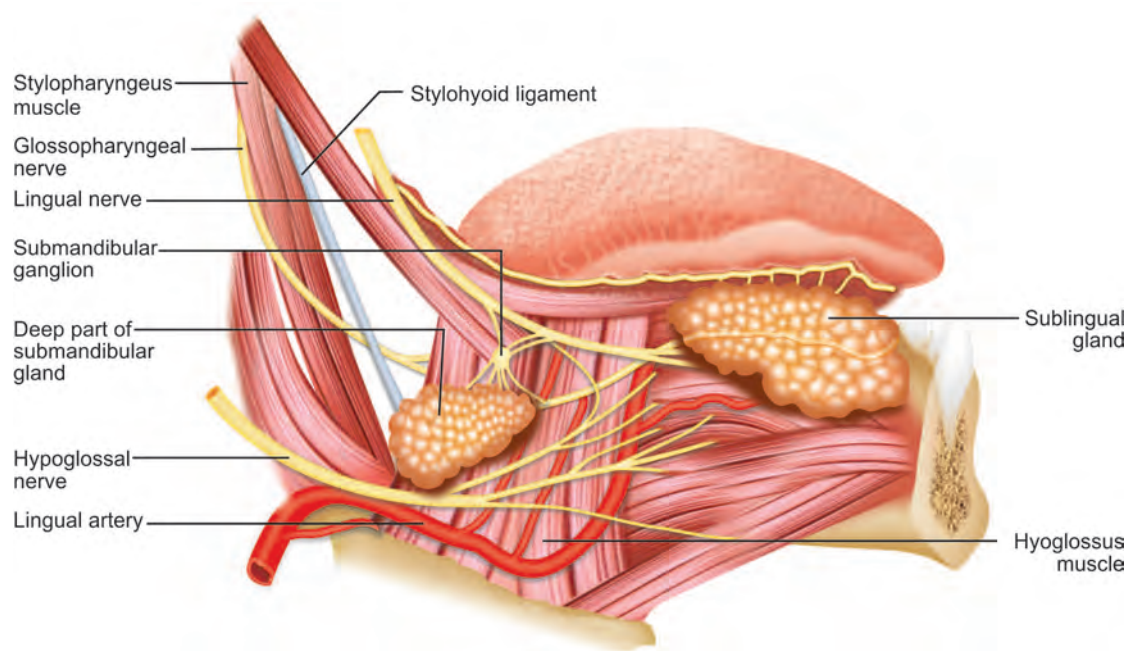


FIGURE 52 Submandibular region

Lingual nerve: Trace this nerve from the mandibular nerve in the intratemporal fossa. It runs across the hyoglossus muscle near its upper border. Trace it forward to the tongue. It is sensory to the anterior 2/3rds of tongue. It carries both general and taste sensations.

Submandibular ganglion: It is one of the parasympathetic ganglia. Note this small ganglion suspended from the lingual nerve by two roots. It receives the preganglionic fibres from the chorda tympani nerve. The fibres after relay in the ganglion supply the submandibular and sublingual salivary glands. See the fine branches arising from the ganglion and entering the deep part of the submandibular gland. The secretomotor fibres to the sublingual gland reach in, through lingual nerve.

Deep part of the submandibular salivary gland: Note this small part deep to the mylohyoid and on the hyoglossus muscle. Trace its thick duct to the undersurface of the tongue near the midline. Observe its opening.

Sublingual salivary gland: Note this gland distal to the hyoglossus muscle on the lateral aspect of the genioglossus muscle.

Hypoglossal nerve: This is the 12th cranial nerve. Trace its origin into the carotid sheath. It runs across the hyoglossus muscle along its lower aspect. Note its communication to the lingual nerve. It is a motor nerve to supply the thyrohyoid (already studied), the styloglossus, hyoglossus, genioglossus, geniohyoid and the intrinsic muscles of tongue.

Lingual Artery (Fig. 53)

Locate this artery opposite to the greater horn of the hyoid bone, arising from the external carotid artery. Locate its first branch, the **suprahyoid branch**. It passes along the upper border of the hyoid bone. **Now detach the hyoglossus muscle from the hyoid bone, lift it up, and trace the lingual artery.** Note the two ascending branches. These are the **dorsal lingual branches**. These branches supply the tongue up to the mucous membrane. Identify the fine branch that supplies the sublingual gland, the **sublingual artery**. Beyond this the continuation of the artery is called as the **deep artery** of the tongue.



REMOVAL OF SPINAL CORD

By this time you have dissected all the postvertebral muscles. Confirm once more that the postvertebral muscles are grouped as the erector spinae group of musculature, signifying their action as an extensor of the vertebral column.

It extends from the sacrum to the external occipital protuberance. In the lumbar region it lies between the middle and posterior layers of the thoracolumbar fascia. In the thoracic region it extends from the spines of the vertebrae to the angles of the ribs. In the neck region it is best developed and well separated. It extends between the spines of the vertebrae to the posterior tubercles of the cervical vertebrae. Inferiorly they extend on to the upper two ribs, superiorly they occupy the space between the external occipital protuberance and the superior nuchal line to the foramen magnum (Fig. 54).

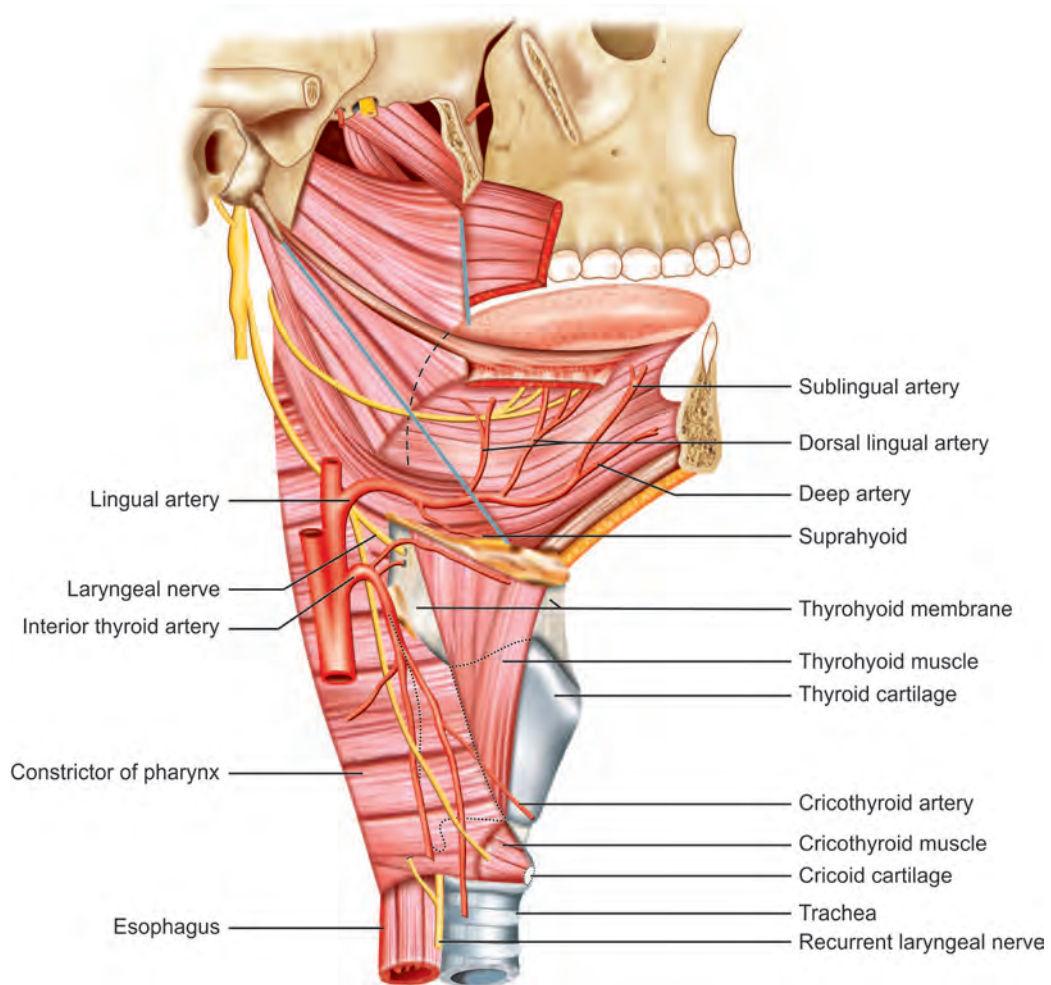


FIGURE 53 Lingual artery

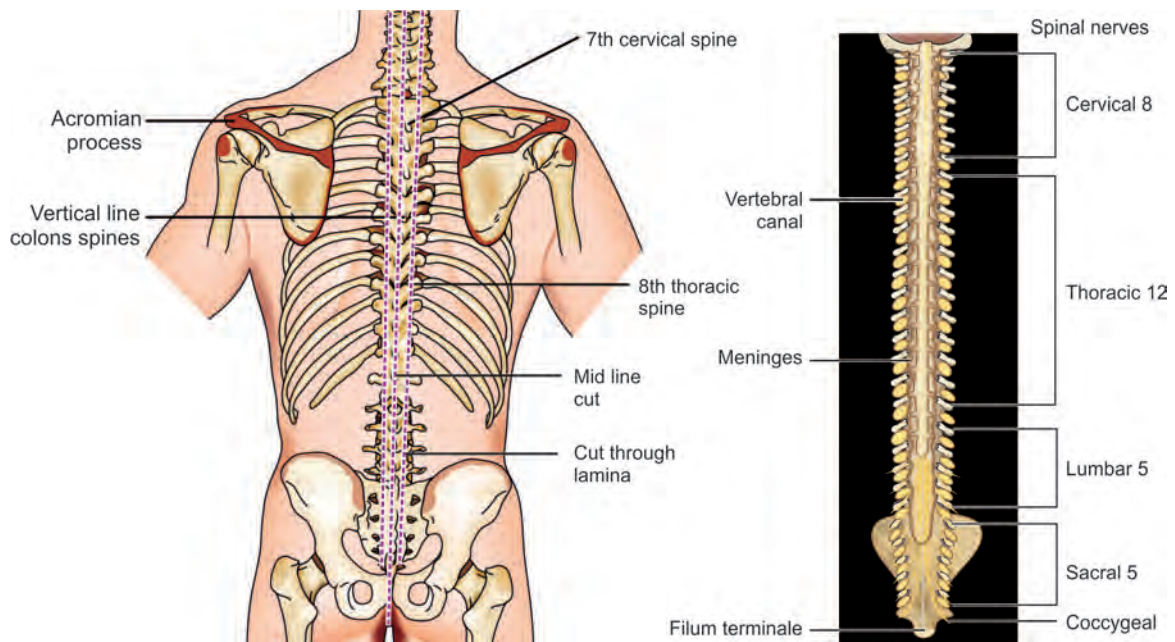


FIGURE 54 Removal of the spinal cord

Dissection: Put the body in a raised prone position, with the neck supported and the head pulled down. Cut and remove all the erector spinae group of muscles from the sacral region to the external occipital protuberance. Expose the vertebrae between the spines and the transverse processes. Use chisel and a saw to cut through the lamina of the vertebrae from the sacrum to the atlas. Slowly chip and remove the total posterior part of the vertebral column from the sacrum to the atlas. Note that the laminae are united by the ligamentum flava. Now you are in the epidural space.

Epidural space: It is the area between the vertebral column and the dura mater. It is filled with **vertebral plexus of veins**. They drain the venous blood from the vertebrae and the spinal cord.

The vertebral plexus of veins are devoid of valves. They communicate with the segmental veins. It is easy for pelvic infections to pass through this route to secondarily infect the vertebrae and brain.

Dissection: Clean the vertebral venous plexus seen in here. The covering that is seen is the dura mater.

Dura mater (Fig. 55): It is the outermost layer of the meninges. It is a tough sheet. Try to mobilize the spinal cord and see. Note that the spinal nerves leave the vertebral canal through the intervertebral foraminae. They are covered by the meninges. The dura mater extends from the foramen magnum to the second sacral vertebra, beyond that identify the thin filum terminale extending up to the coccyx.

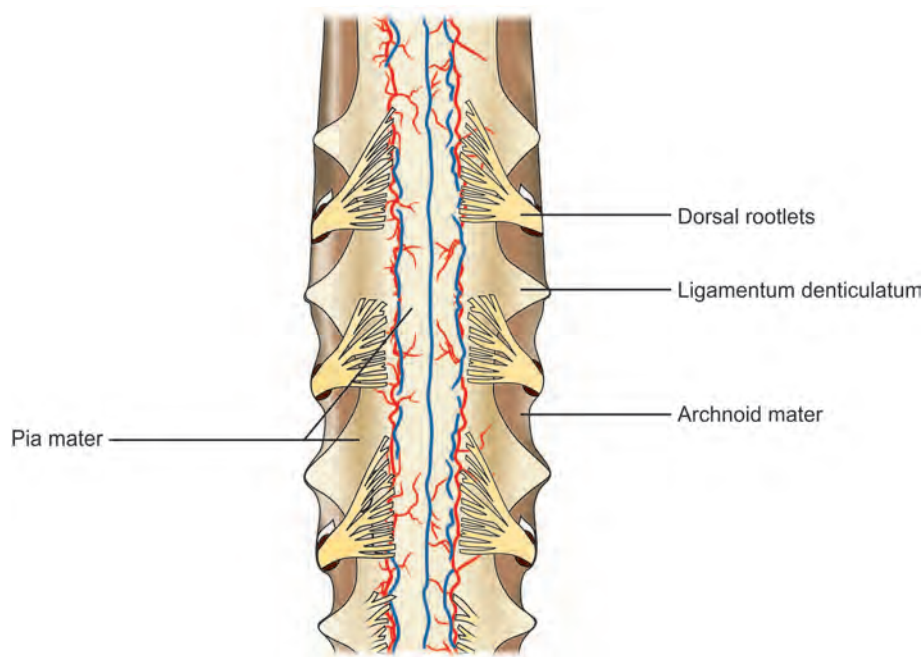


FIGURE 55 Dura mater (spinal cord)

Dissection: Remove the spinal cord along with the meninges by gradually cutting the spinal nerves and lifting it from the vertebral canal. Remove the spinal cord from the cervical level to the sacral level. As you are lifting note that the spinal cord extends up to the lower border of the first lumbar vertebra, beyond that it is made up of bunch of nerves. As you are lifting note the lower end of the dura mater closing at the level of the second sacral vertebra and the meninges continue as the filum terminale to the coccygeal vertebra.



CRANIAL CAVITY

The cranial cavity is occupied by the brain. It is covered by three meninges—the pia mater, the arachnoid mater and the dura mater in that order from inside out. The dura mater is very thick. It is made up of two layers, the endosteal and the meningeal layers. The meningeal layer sends in sheets to separate different parts of the brain. The venous sinuses lie at the point of their separation. All the cranial nerves leave the cranial cavity through the foraminae in the skull.

In this study you remove the brain from the cranial cavity along with the pia and arachnoid mater. While removing the brain you will be cutting the cranial nerves arising from it. You will study the dura mater and the venous sinuses as you try to remove the brain.

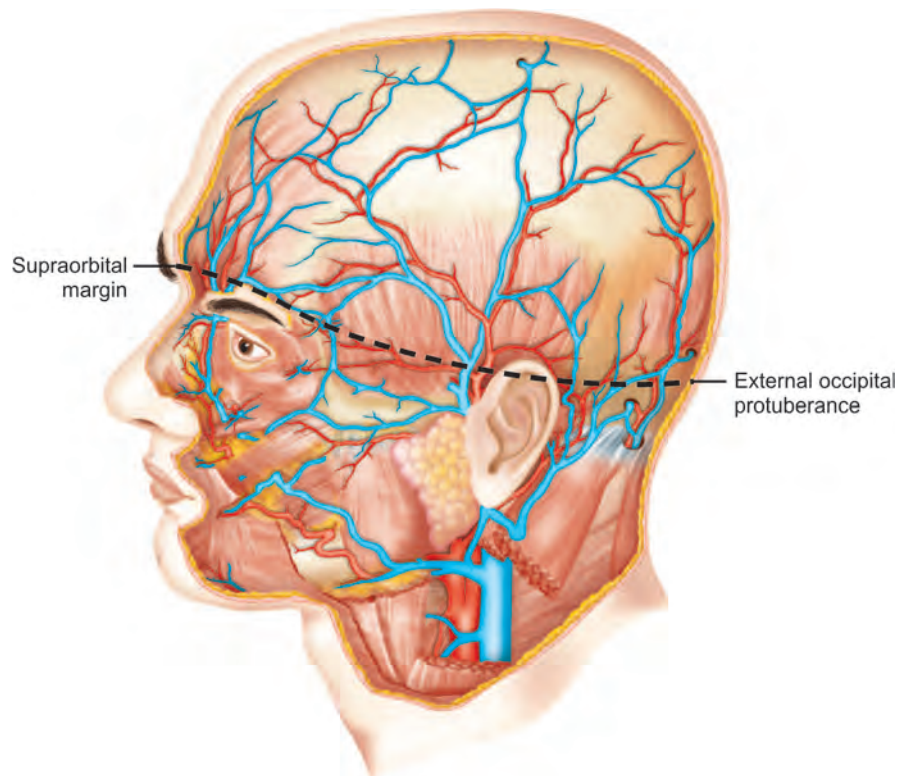


FIGURE 56 Removal of the skull cap

Dissection (Fig. 56): Removal of skull cap—clean all the muscles from the scalp, back, suboccipital muscles and temporalis.

Take a wet chalk piece and make a mark from (1) Just below the supraorbital margin anteriorly (2) Along the upper border of the attachment of auricle, (3) To a point below the external occipital protuberance. Cut it with a saw and remove the skull cap making sure that you retain the dura mater *in situ*. Use hand or edge of the scalpel to ease the dura mater from the skull. In general near the midline there can be erosion of the skull cap by the arachnoid granulations. Take more care in this area.

Dura Mater (Fig. 57)

It is the thick white glistening meninges that is exposed now. Note the prominent ***middle meningeal artery*** on the superolateral aspect of the dura mater. This reaches the dura through the foramen spinosum. This is a branch of the first part of the maxillary artery. This is the major artery of supply to the dura mater.

VENOUS SINUSES

The veins of the cranial cavity present a nonvalvular sinus pattern. The venous sinuses lie between the endosteal and meningeal layer of the dura mater. The superior sagittal sinus, the inferior sagittal sinus and the straight sinus lie in the midline. The sphenoparietal sinus, the cavernous sinus, the

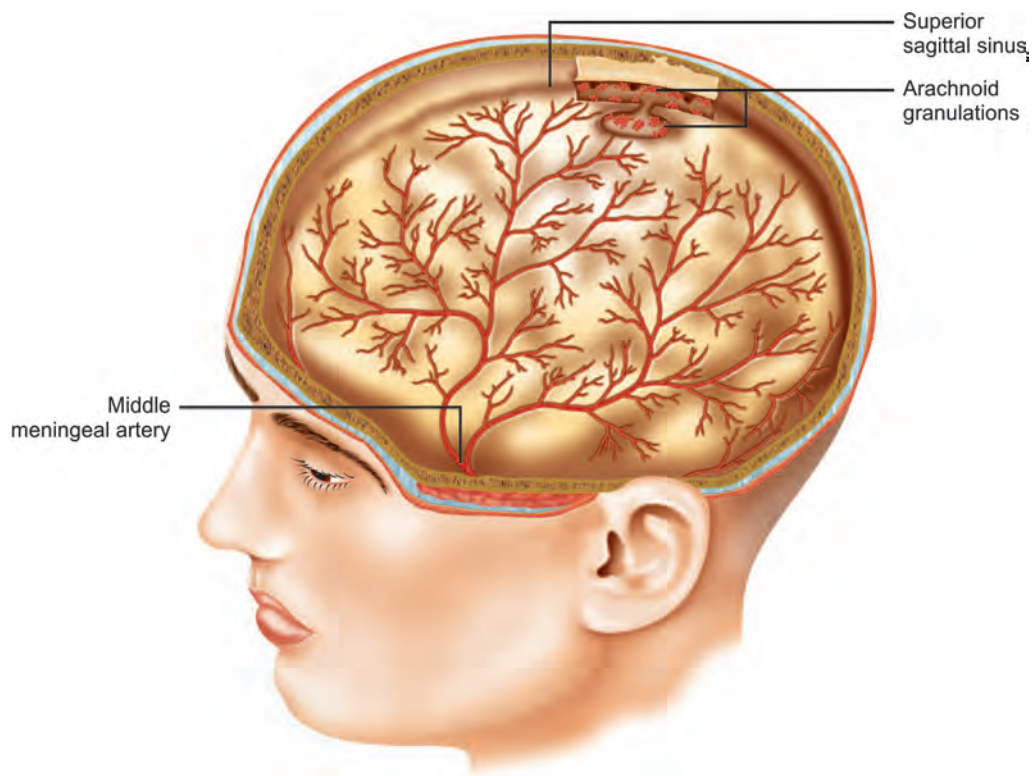


FIGURE 57 Dura mater (Brain)

intercavernous sinuses, the superior and inferior petrosal sinuses are paired sinuses and lie on either side of the midline.

Superior sagittal sinus: This lies in the midline from the foramen cecum to the level of external occipital protuberance. Slit the dura mater in the midline and see its interior. Put fine probes and identify the veins opening into it. These veins drain the cerebrum.

Arachnoid granulations: These are fine grape like structures projecting into the venous lacunae by the side of the superior sagittal sinus. These are projections of the arachnoid mater. The cerebrospinal fluid located in the subarachnoid space is poured into the venous sinus here.

Dissection: Make two parallel cuts on either side of the superior sagittal sinus. Make a coronal cut from one ear to the other ear through the dura mater reflect the four flaps towards the side of the skull. Leave the falx cerebri in position. Study the forebrain. Look at the frontal lobe, parietal lobe, occipital and temporal lobes of the cerebrum. Lift them up from the anterior, middle cranial fossae. Lift up the frontal lobes, and see in the midline. You can see the optic nerves, optic chiasma, internal carotid arteries and infundibular stalk. With fine scissors cut them, continue to cut the oculomotor nerve, trochlear which are located at a slightly posterior plane.

Turn the body to a prone position. Lift the occipital lobes and see the tentorium cerebelli. Locate its attached margin. It extends from the internal occipital protuberance, along the occipital bone to the superior border of the petrous part of the temporal bone.

Identify the transverse sinus along the occipital bone.

Falx cerebri: Identify this from the crista galli to the level of external occipital protuberance. Cut it near the crista galli and pull it up to the tentorium cerebelli. Cut the tentorium cerebelli inner to the attached margin (Central part of the tentorium lies between the cerebrum and cerebellum). Ease the cerebellum from the posterior cranial fossa and feel the foramen magnum and medulla oblongata. Nearer to foramen magnum pull the falx cerebelli posteriorly and lift the cerebellum and medulla oblongata from the posterior cranial fossa. Carefully lift the temporal and occipital lobes. Put a scissors along the inner surface of the petrous part of temporal bone and cut the facial, vestibulocochlear, trigeminal, glossopharyngeal, abducent, vagus and accessory nerves. Put the scissors near the foramen magnum along its sides and cut the vertebral arteries and hypoglossal nerves. Slowly carefully lift up the whole brain. In this removal the whole brain is removed along with the arachnoid mater and all blood vessels and nerves. Along with the brain the central part of the tentorium cerebelli comes off. So it can be pulled out after the removal, and put it back in the anatomical position and can be studied.

Alternative Method to Remove the Brain in Two Pieces

Dissection: Cut the falx cerebri near the cristagalli and pull it up, up to the tentorium cerebelli. Lift the temporal, occipital lobes of the cerebrum from the tentorium cerebelli. Use a sharp blade, make a transverse cut through the brain in the midline. The cut will go through the midbrain. As the anterior structures were already cut the forebrain can be lifted up easily.

Study of the Tentorium Cerebelli (Fig. 58)

Look for the glistening dura mater. It is a fold of the meningeal layer of the dura mater. It has got an attached margin along the inner side of the occipital bone from the internal occipital protuberance to the petrous part of the temporal bone, along the superior border of the petrous part of the temporal bone to the posterior clinoid process. Free margin of tentorium cerebelli is a 'U' shaped margin and anteriorly it is attached to the anterior clinoid process.

Straight sinus: Locate this at the junction of superior sagittal sinus with the tentorium cerebelli.

Transverse sinus: Slit the tentorium cerebelli along the attached margin of the tentorium cerebelli with the occipital bone. Observe the transverse sinus.

Inferior sagittal sinus: See this in the free margin of the falx cerebri and identify the formation of straight sinus by the union of inferior sagittal sinus and great cerebral vein of Galen.

Dissection: Cut through the attached margin of the tentorium cerebelli and remove it. Note the trochlear nerve located between the free and attached margins of the tentorium cerebelli.

Observe the hindbrain. See the cerebellum in the posterior cranial fossa. Note the midbrain, pons and medulla oblongata anterior to the cerebellum. Push the brainstem posteriorly. Note the oculomotor, trochlear, trigeminal, facial and vestibulocochlear nerves. Cut them nearer to the bone. Push the medulla oblongata further and cut the 6, 9, 10, 11, 12 cranial nerves and the vertebral artery nearer to the foramen magnum and jugular foramen.

Push the brainstem and cerebellum forwards, pull the falx cerebelli backwards and cut the medulla oblongata near the foramen magnum and lift the hindbrain. This will remove the hindbrain along with all the cranial nerves from 3rd to 12th and the vertebral artery along with pia and arachnoid mater.

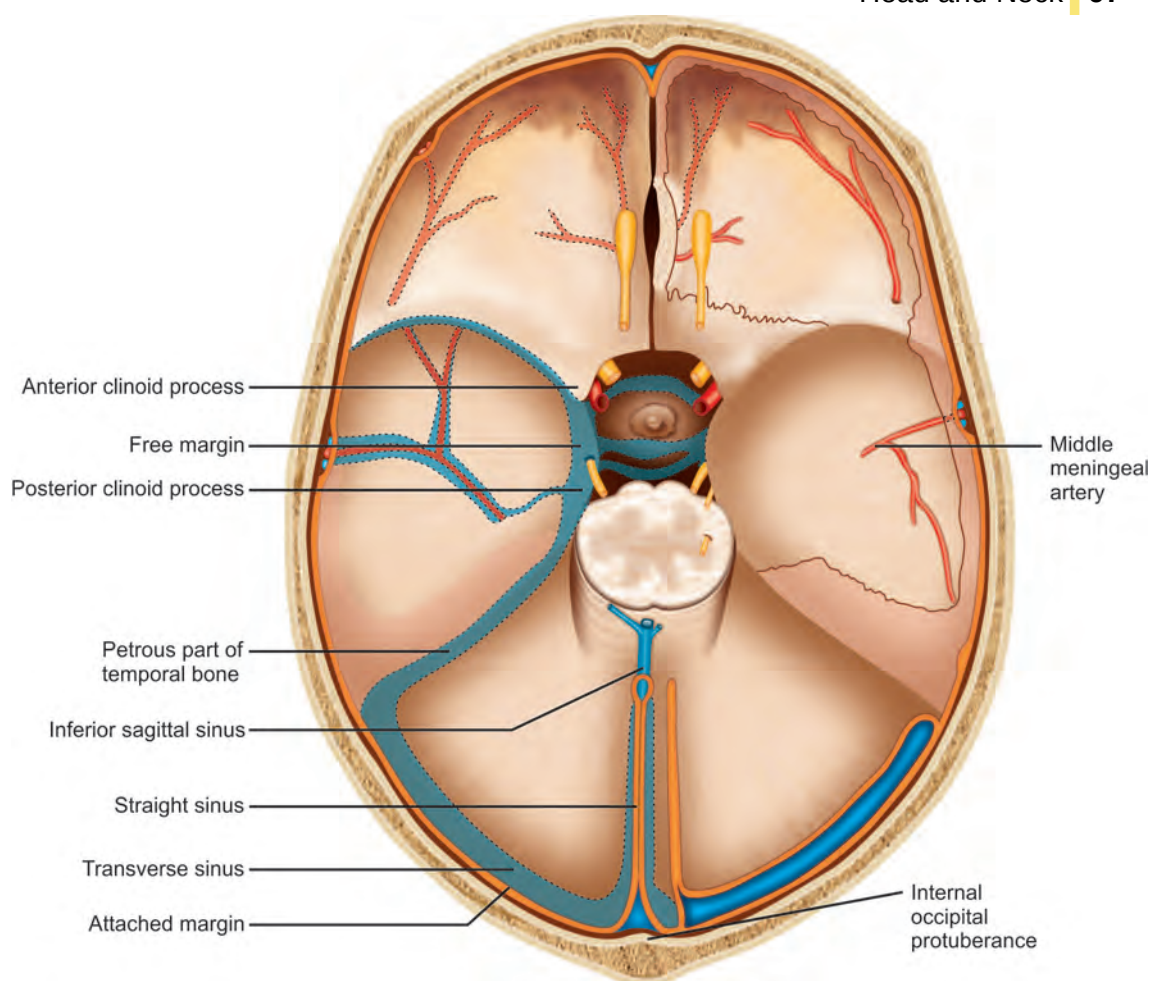


FIGURE 58 Tentorium cerebelli

Middle meningeal artery: Note this bulging artery within the lateral aspect of the dura mater. Note its branches supplying the dura mater. Trace it down to its emergence from the foramen spinosum.

INTERIOR OF SKULL (Fig. 59)

After removing the brain, the interior of the skull which now is still covered by the dura mater, the arteries, dural venous sinuses and cranial nerves can be studied.

ARTERIES

Vertebral artery: This enters the cranial cavity through the foramen magnum. Note the cut end of this artery within the foramen magnum.

VENOUS SINUSES

Internal carotid artery: Note this artery lateral to the optic chiasma. This artery enters the cranial cavity through the carotid canal, passes through the cavernous sinus (will be dissected soon) and enters the brain lateral to the optic chiasma.

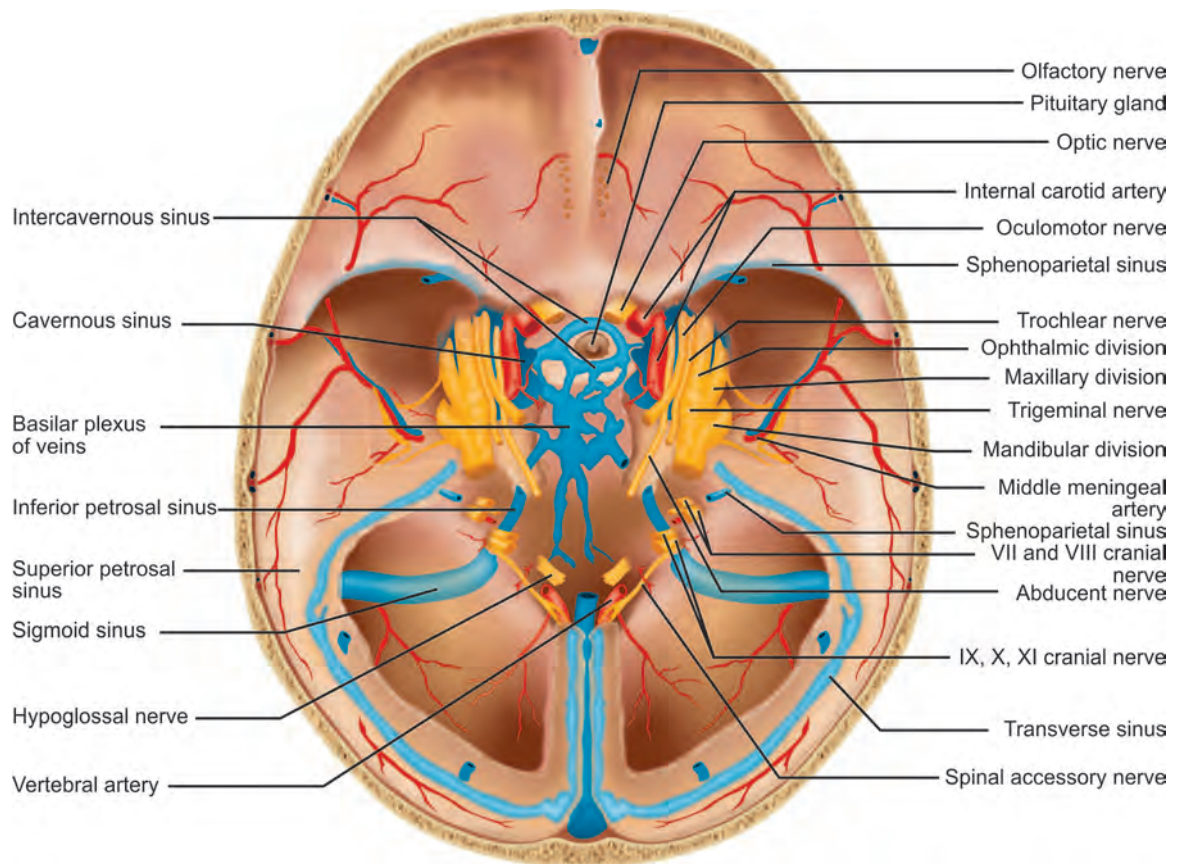


FIGURE 59 Cranial nerves and venous sinuses—base of skull

Sphenoparietal sinus: This sinus lies along the lesser wing of sphenoid. This drains into cavernous sinus.

Cavernous sinus: This sinus lies lateral to the pituitary gland. The oculomotor, trochlear, ophthalmic and mandibular division of trigeminal nerve lie in the lateral wall of the cavernous sinus.

Dissection: Peel the dura mater off the lateral wall and identify these nerves.

Internal carotid artery and abducent nerve lie within the cavernous sinus. Locate them. Anterior, posterior and intercavernous sinuses connect the cavernous sinuses of either side.

Superior petrosal sinus: Slit the attached margin of the tentorium cerebelli along the petrous part of the temporal bone and note that it connects the cavernous sinus to the transverse sinus.

Inferior petrosal sinus: Locate this sinus from the cavernous sinus to the jugular foramen. It can be seen as a blue line. Slit it open and see the sinus.

Basilar plexus of veins: Locate these through the dura mater over the basilar part of the occipital bone.

Occipital sinus: Locate this within the attached margin of falx cerebelli.

CRANIAL NERVES

I. Olfactory nerve: This enters the skull as 20 rootlets through the cribriform plate of ethmoid bone. Note these openings in the ethmoid bone. It carries olfactory sensations.

II. Optic nerve: Trace it in the optic canal. It carries visual sensations.

III. Oculomotor nerve: This is a thick nerve passing through the free margin of the tentorium, into the lateral wall of the cavernous sinus to the superior orbital fissure. It is a motor nerve. It supplies the muscles of eyeball.

IV. Trochlear nerve: This is a thin nerve. Locate it between the free and attached margins of the tentorium cerebelli passes along the lateral wall of the cavernous sinus to the superior orbital fissure. It is motor to superior oblique muscle of eyeball.

V. Trigeminal nerve: It is a thick nerve, locate it in the posterior cranial fossa. It pushes the dura mater into the middle cranial fossa forming a covering to itself called the *cavum trigeminal*. Slit the dura mater and locate the ganglion and its branches.

Ophthalmic division is the most superior of the divisions. It passes along the lateral wall of the cavernous sinus to the superior orbital fissure. It is a sensory nerve to the face.

Maxillary division is the middle branch of the trigeminal nerve. It runs along the lateral wall of the cavernous sinus. It is sensory to the maxilla.

Mandibular nerve leaves the cranial cavity through the mandibular foramen. It is a mixed nerve. Locate the deeper motor part of this nerve. It supplies muscles of mastication and is sensory to the face and mandible.

VI. Abducent nerve: Locate this thin nerve piercing dura mater of posterior cranial fossa. It passes through the cavernous sinus along with the internal carotid artery. Trace it to the superior orbital fissure.

VII and VIII. Facial and vestibulocochlear nerve: These nerves enter the internal auditory meatus in the petrous part of the temporal bone. Locate the fine labyrinthine artery in the posterior cranial fossa which accompanies these nerves.

IX, X and XI. Glossopharyngeal, vagus and accessory nerves: They enter the jugular foramen. Locate the spinal part of the accessory which ascends up through the foramen magnum to join the cranial part of the accessory nerve.

XII. Hypoglossal nerve: Locate this nerve passing through the hypoglossal canal just above the foramen magnum.



ORBIT

BONY ORBIT (Fig. 60)

Study the bony orbit on the dry skull. Note that it is a pyramidal shaped area. Its medial walls are parallel to each other whereas its lateral walls diverge laterally. Locate the followings:

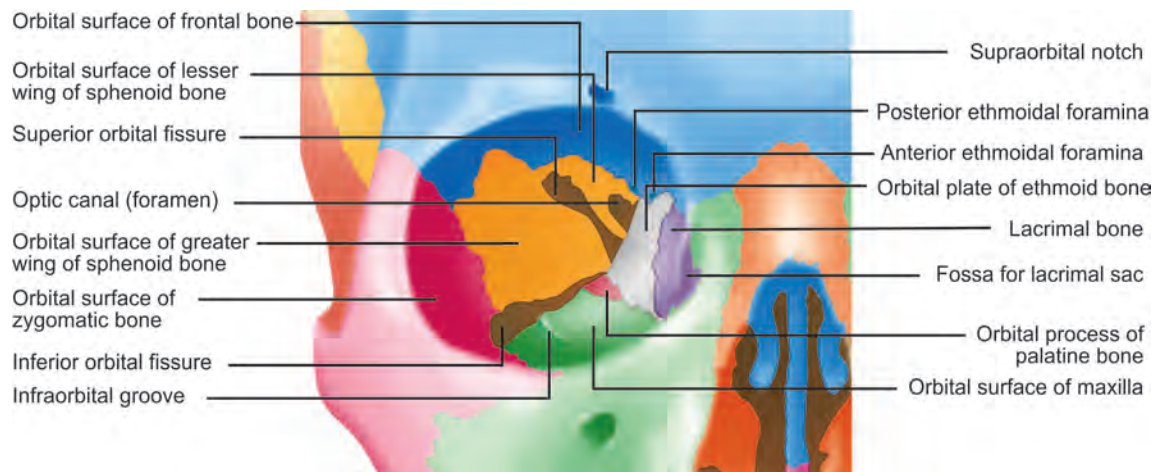


FIGURE 60 Bony orbit

Optic canal is formed by the two roots of the lesser wing of the sphenoid and the body of the sphenoid.

Superior orbital fissure is formed by the lesser wing and greater wing of sphenoid.

Inferior orbital fissure formed by the greater wing of sphenoid, maxilla and the zygomatic bone.

Anterior, posterior ethmoid canals are fine canals between the ethmoid and the frontal bone.

Internal orifice in the zygomatic bone is a fine foramen in the zygomatic bone.

Trochlea is a rough part on the medial part of the roof.

Supraorbital foramen or notch can be felt in the supraorbital margin.

Dissection (Fig. 61): Make two saw cuts along the medial and lateral ends of the superior orbital margin to the superior orbital fissure. Remove the roof and lateral wall of the orbit taking care not to damage the deeply located orbital periosteum.

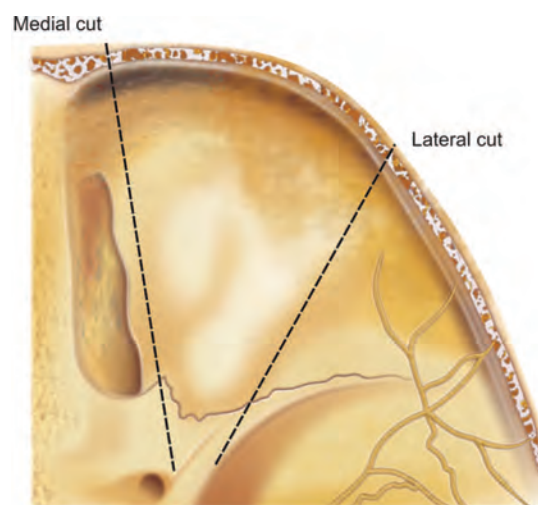


FIGURE 61 Dissection of orbit

SUPERFICIAL STRUCTURES OF THE ORBIT

Orbital periosteum envelops the contents of the orbit. The orbit has the lacrimal gland, eyeball with the optic nerve, muscles to move the eyeball, sensory nerves to supply the internal structures and skin, autonomic fibres to supply the interior of eyeball and the ophthalmic artery with its accompanying veins. You will identify all these structures as and when they appear in dissection (**Fig. 62**).

Dissection: Cut and remove the thick glistening orbital periosteum from the roof. Identify the three nerves extending from the middle cranial fossa to the orbit.

Trochlear nerve: Trace this most medial nerve into the superior margin of the superior oblique muscle nearer to its origin. Trace this nerve back to the lateral wall of the cavernous sinus. It supplies the superior oblique muscle.

Frontal nerve: This is the thick nerve seen right in the middle. Trace it back to the ophthalmic division of trigeminal nerve. Note that it immediately divides into two branches, the medial supratrochlear branch and thick lateral supraorbital nerve. Trace the nerves forwards along the superior orbital margin to the scalp. It is sensory to scalp.

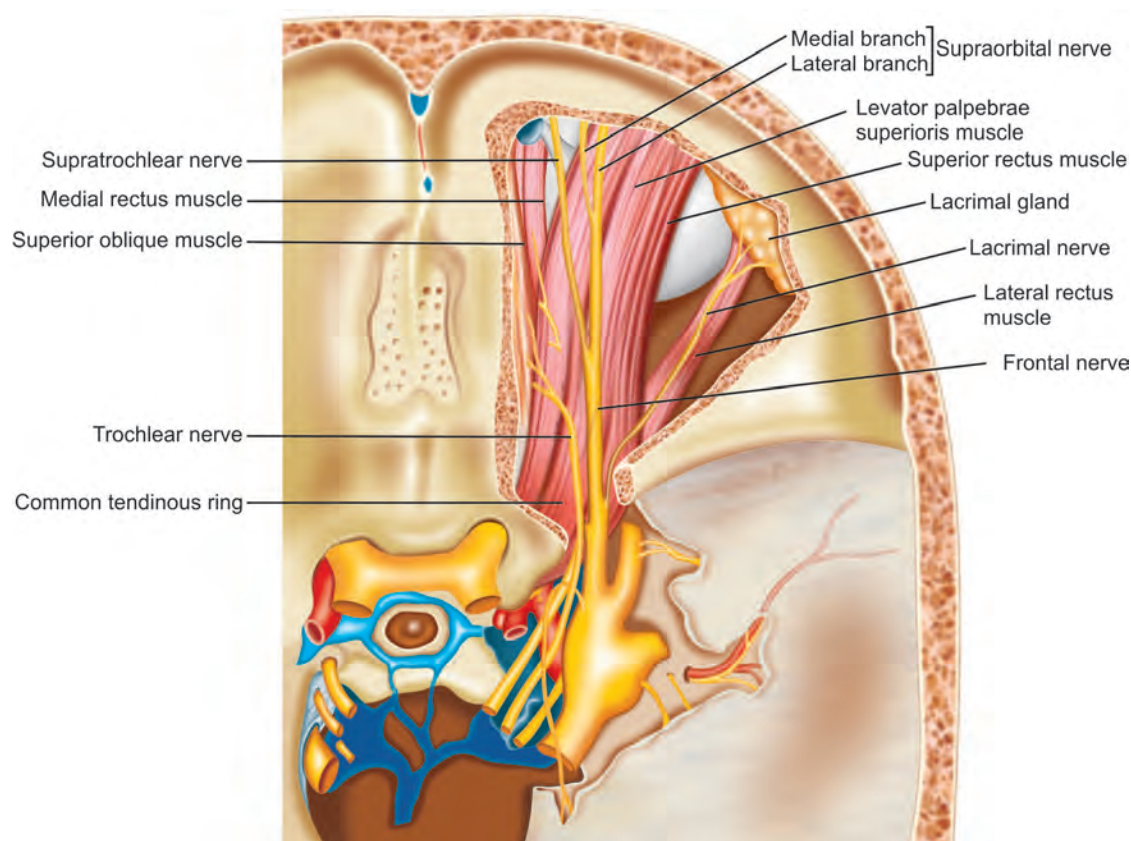


FIGURE 62 Superficial structures of the orbit—superior aspect

Lacrimal nerve: It is a thin lateral branch along the superiolateral margin. Trace it back to the ophthalmic division and trace it forward to the lacrimal gland. Trace a fine zygomatic branch joining this nerve. The zygomatic branch brings in secretomotor fibres from the maxillary nerve to the lacrimal gland.

Lacrimal gland: It secretes tears. It is a light yellow color gland located on the anterolateral aspect of the orbit. It is divided into a superficial and a deeper part by the aponeurosis of the levator palpebrae superioris muscle. Locate this gland and identify its parts.

Dissection: Detach the nerves and reflect them towards the middle cranial fossa.

MUSCULATURE OF THE ORBIT

Orbit lodges the four recti, two oblique which act on the eyeball and a palpebral muscle which elevates the upper lid. The significant feature here is that the recti arise from a common tendinous ring located proximally near the superior orbital fissure. They all insert into the anterior half of the eyeball. Note that they move anterolaterally to reach their insertion. The oblique are inserted into the posterior half of the eyeball and they run anteroposteriorly.

Superior oblique muscle: Locate this muscle along the superomedial margin of the orbit. It arises from the common tendinous ring. Trace it to the trochlea at the anterior end and feel it. It is inserted into the superolateral surface of the eyeball posterior to the equator (you will see the insertion after reflecting the other muscles). Locate its nerve supply from the trochlear nerve.

Dissection: Cut the muscle between the origin and trochlea

Levator palpebrae superioris: Identify this muscle which occupies the whole central area. It arises from the under surface of the orbital plate of the frontal bone and is inserted into the upper eyelid. Note the deeper fibres inserted into the conjunctiva. The muscle fibres spread out as they move forwards. Note that it elevates the upper eyelid by pulling it.

Dissection: Cut it in the centre reflect the proximal part towards its origin and the distal part towards its insertion.

Superior rectus: Note this muscle immediately deep to the levator palpebrae superioris. It arises from the tendinous ring. Note the margin from where it arises. Trace its insertion into the superior part of the eyeball in front of the equator. It is an elevator of the cornea.

Medial rectus muscle: Locate this muscle along the medial side of the orbit. It arises from the tendinous ring and gets inserted into the medial side of the eyeball. It is an adductor of the eyeball.

All the three muscles are supplied by upper division of the oculomotor nerve. The nerve enters into the muscles on their deeper aspect.

Dissection: Cut the muscle in the center and reflect the proximal part towards the origin and the distal part towards the insertion. Cut through the tendinous ring between the origin of the superior rectus and lateral rectus. Locate the oculomotor nerve entering into the orbit through the superior orbital fissure. Trace it backwards to its location in the cavernous sinus. Trace its branches entering into the levator palpebrae superioris, superior rectus and medial rectus.

DEEP STRUCTURES OF ORBIT (Fig. 63)

Insertion of superior oblique: Trace this muscle from the level of the trochlea. Note that the muscle becomes aponeurotic and spreads out. It is inserted into the superolateral surface of the eyeball posterior to the equator. Clean the orbital fat and trace the insertion. Note that this muscle pulls the posterior part of the eye all upwards and medially and produces downward and lateral movement of the cornea

Nasociliary nerve: Clear the fat in the orbit and locate the nasociliary nerve crossing the optic nerve from lateral to medial. Trace it back to the ophthalmic division and forwards to the ethmoid between medial rectus and superior oblique muscles. This is the sensory nerve to the orbital structures and the ethmoidal air sinuses. It gives off fine **anterior and posterior ethmoidal nerves** which pass through the canals in the ethmoid bone. The anterior ethmoidal nerve after supplying the ethmoidal air sinus enters the nasal cavity to supply the mucous membrane of nose. The nasociliary reaches the face as the **infratrochlear nerve** and supplies the skin of the face.

Lateral rectus muscle: Locate this muscle along the lateral side of the orbit. It arises from the tendinous ring and is inserted into the lateral aspect of the eyeball. It is an abductor and is supplied by the abducent nerve.

Abducent nerve: Locate this nerve into the inner aspect of the muscle. Trace it backwards to the superior orbital fissure and the cavernous sinus.

Optic nerve: Locate this thick nerve entering into the orbit through the optic canal. It is the sensory nerve to carry the visual sensations.

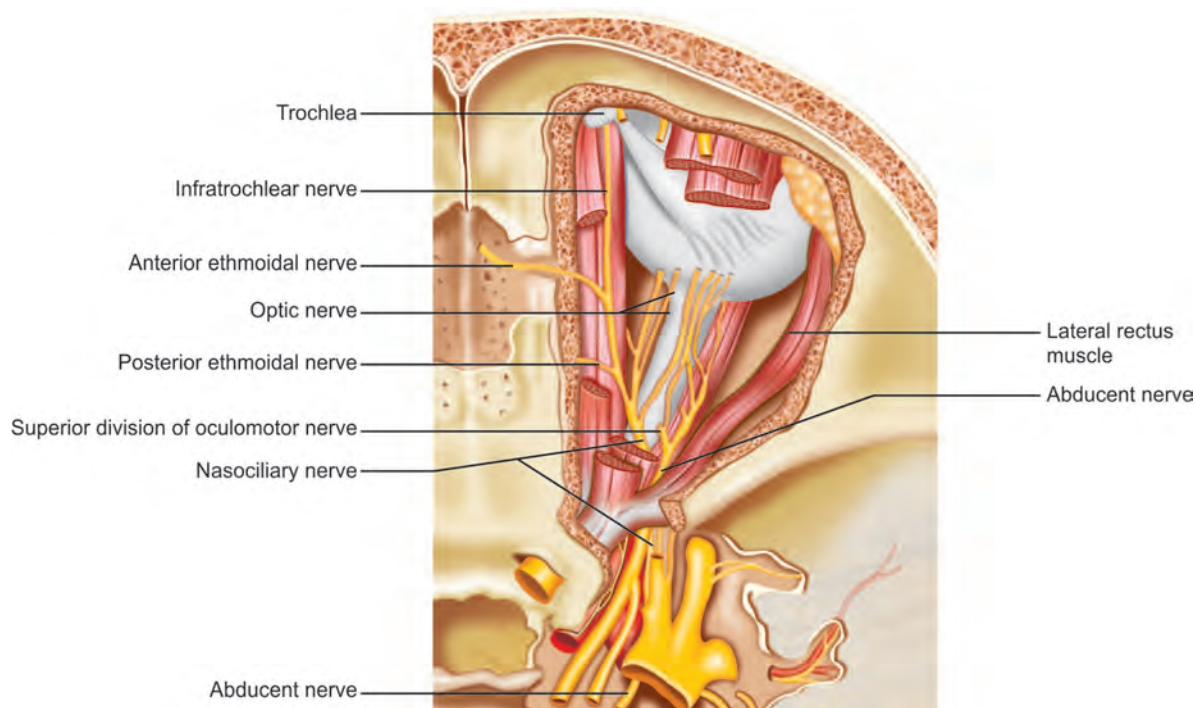


FIGURE 63 Deep structures in the orbit

OPHTHALMIC ARTERY (Fig. 64)

Locate this artery inferior to the optic nerve in the optic canal. Trace it forwards and see all its fine branches. It divides into a **lacrimal branch** which moves forwards and into the eyelid after supplying the lacrimal gland. The medial branch crosses the optic nerve either superficial or deep to the nerve. As it crosses the nerve it gives off **ciliary branches** to supply the eyeball. The **central artery of retina** enters the optic nerve while the ophthalmic artery lies deep to the optic nerve. It is an end artery and supplies the retina. The ophthalmic artery further runs medially and parallel to the medial wall of the orbit. Here it gives off the **ethmoidal branches** to enter the ethmoidal canals. They supply the ethmoidal air sinuses. The **supraorbital** is an independent branch. The ophthalmic artery gives the **medial palpebral artery**, to the lids, **supratrochlear artery** to the scalp and **dorsal nasal** to the nose. Throughout its course it gives off branches to supply the orbital structures.

Veins in the orbit exhibit a plexiform arrangement and leave the orbit as superior and inferior ophthalmic veins. The **superior ophthalmic vein** accompanies most of the branches of the artery and leaves through the superior orbital fissure and drains into cavernous sinus. The **inferior ophthalmic vein** drains the inferior structures and leaves it through the inferior orbital fissure. This drains into the pterygoid plexus of veins.

Dissection: Try to chip the lateral wall of the orbit up to the superior orbital fissure. This gives more space here to trace the important structures. Cut the lateral rectus muscle in its center and reflect it. See the following structures (**Fig. 65**).

Ciliary ganglion is a parasympathetic ganglion. Pull the optic nerve medially and locate this small ganglion between it and the lateral rectus. Very near the apex of the orbit. You can see it suspended

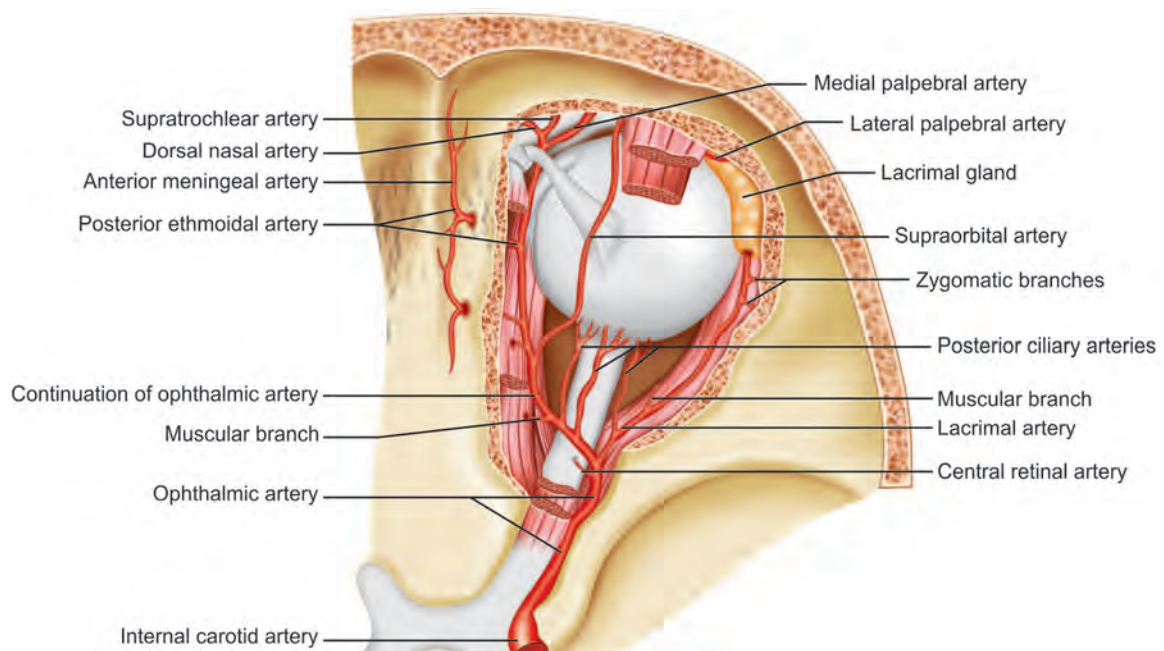


FIGURE 64 Ophthalmic artery

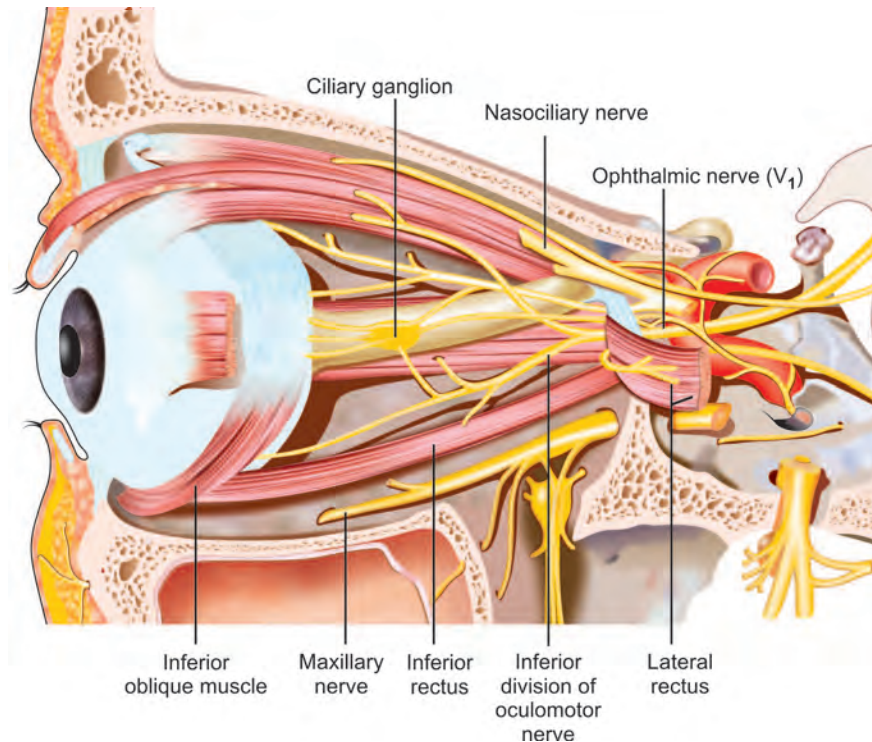


FIGURE 65 Lateral exposure of orbit

by the nasociliary and inferior division of oculomotor nerve. Locate the **short** and **long ciliary nerves** arising from the ganglion and from the nasociliary nerve. Trace them reaching the back of the eyeball. These carry the autonomic and sensory fibres to the muscles within the eyeball.

Inferior oblique muscle: Locate this muscle in the floor extending from medial to lateral side. It arises from the medial aspect of the floor of the orbit. It is inserted into the inferolateral surface of the eyeball, posterior to the equator. It pulls the posterior aspect of the eyeball downwards and medially thus resulting in the upward and lateral movement of the cornea.

Inferior rectus muscle: Depress the inferior oblique muscle and pull the eyeball up and locate this muscle in the undersurface of the eyeball. It arises from the fibrous tendinous ring on its inferior aspect. It is inserted into the eyeball on its inferior surface **anterior to the equator**.

Inferior division of oculomotor nerve: Locate this nerve lateral to the optic nerve. It enters into the orbit through the superior orbital fissure. Trace it back to the oculomotor nerve. Trace its branches entering into the inferior rectus and inferior oblique muscles on their internal surfaces.

Maxillary nerve: Trace this nerve from the middle cranial fossa through the foramen rotundum to the floor of the orbit. Trace it into the infraorbital groove/canal.

Facial sheath of the eyeball: Pull the eyeball upwards and locate the connective tissue sheath from below the eyeball to the medial and lateral bony walls. They are called medial and lateral palpebral ligaments. All the muscles of the eyeball get inserted into the eyeball through this facial sheath.

LACRIMAL APPARATUS (Fig. 66)

The lacrimal apparatus manufactures tears, pours it on to the eyeball to moisten the eyeball. The excess tears are drained to the nasal cavity.

Lacrimal apparatus consists of **lacrimal gland** with its **excretory ducts**—this lies within the orbit, **conjunctival sac**—this is the space between the two eyelids and the eyeball, **lacrimal papillae and puncta**—these lie within the medial ends of the eyelid, the **lacrimal canaliculi**—these run from the puncta to the lacrimal sac, the lacrimal sac—this lies deeper to the medial palpebral ligament, the **nasolacrimal duct**—this drains the lacrimal sac to the **inferior nasal meatus**.

Many of these structures are small and deeply placed and are difficult to identify. The structures are described at the appropriate place.

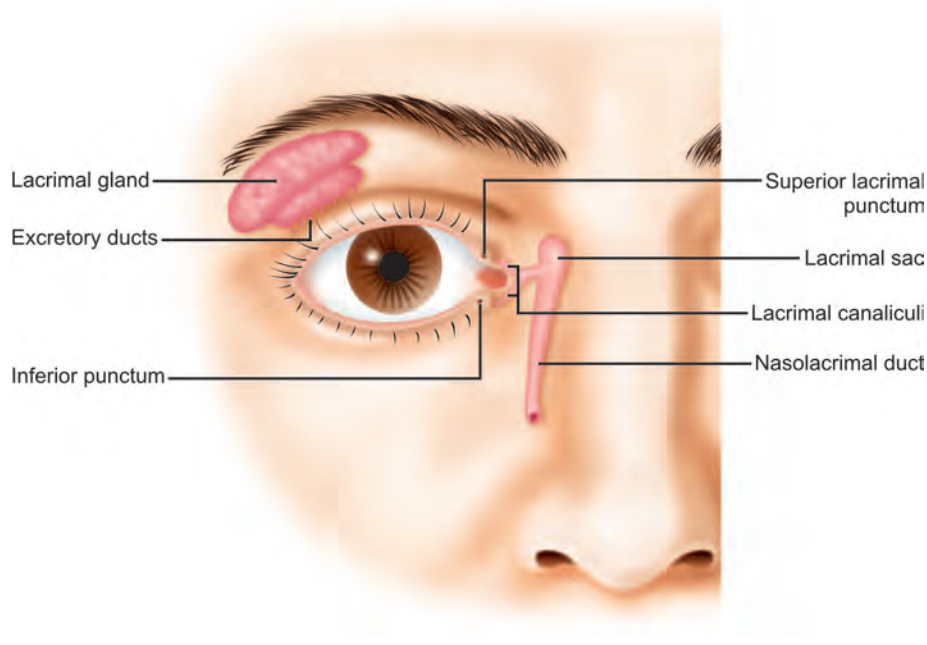


FIGURE 66 Lacrimal apparatus

NOSE

The part of the nose that is seen externally is **external nose**. Feel it and note that it is both bony and cartilaginous. But when it is cut in the midline the total area extending from the anterior nasal aperture to the posterior choanae is considered as the nasal cavity.

Nasal cavity is a respiratory passage. It is divided into two parts by a septum. The surface area of the nasal cavity is increased by bony projections. The bones surrounding the nasal cavity are pneumatic bones, filled with air. They help in the resonance of the voice. The part seen externally

is called the external nose. It is made up of both bone and cartilage. All the bones and cartilages of the nasal cavity are covered by the mucoperiosteum. The function of the cavernous tissue is to control the temperature of the passing air. It warms in cold climate and cools in warm climates. The roof of the nasal cavity is olfactory in nature and is supplied by the olfactory nerves.

BOUNDARIES OF THE NASAL CAVITY (Figs 67 to 69)

It is divided into two halves by the median nasal septum. Note that it is made up of bone as well as cartilage. Identify the ethmoid, vomer and the space for the septal cartilage.

Observe that the lateral wall exhibits projections called conchae. Note that the wall is made up of maxilla, lacrimal, ethmoid, palatine, sphenoid and inferior nasal concha. Note the sphenopalatine foramen in the vertical plate of the palatine bone between its two roots. Note the area for cartilage.

Dissection: Use a band saw and detach the neck at the level of 7th cervical vertebra and make a sagittal section in the midline and separate it into two halves.

See the *median septum* in the section and feel that it is covered by mucoperiosteum.

Dissection: Strip the mucoperiosteum and try to locate the thin nasopalatine nerve and artery posteriorly and identify the internal nasal nerve and artery (branches of nasociliary) anteriorly.

Identify the **roof** that is sloping both anteriorly as well as posteriorly.

Floor: The floor of the nasal cavity is same as the roof of the oral cavity. It is formed by the palate (It will be studied at a later stage of dissection).

Choanae is the posterior margin of the nasal cavity where it is continuous with the nasopharynx. It is bounded by the roof, lateral wall, septum and floor of the nasal cavity.

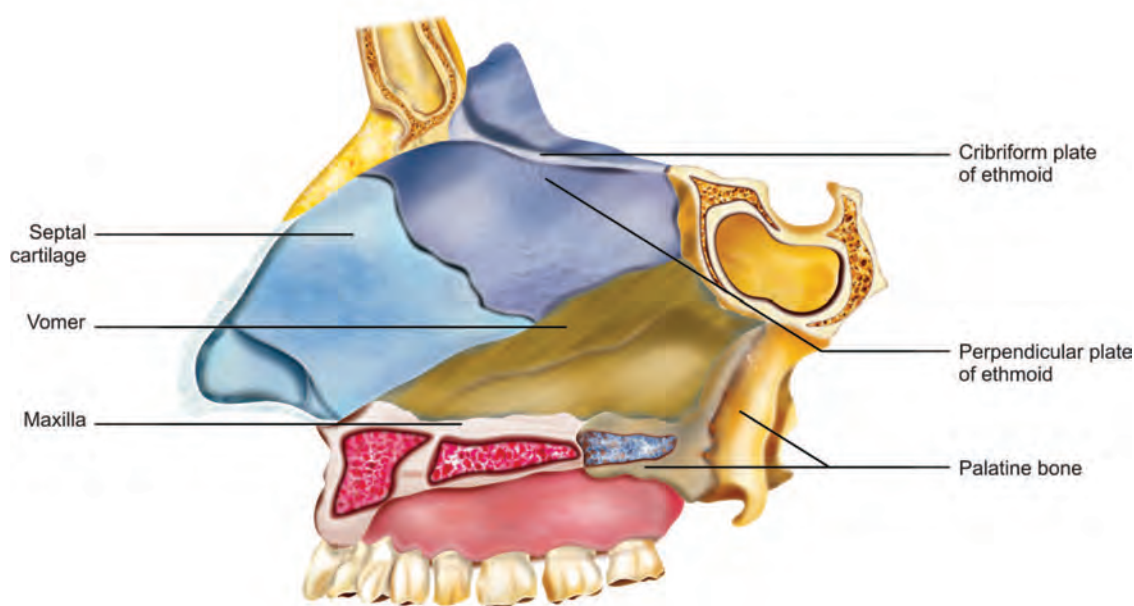


FIGURE 67 Nasal septum

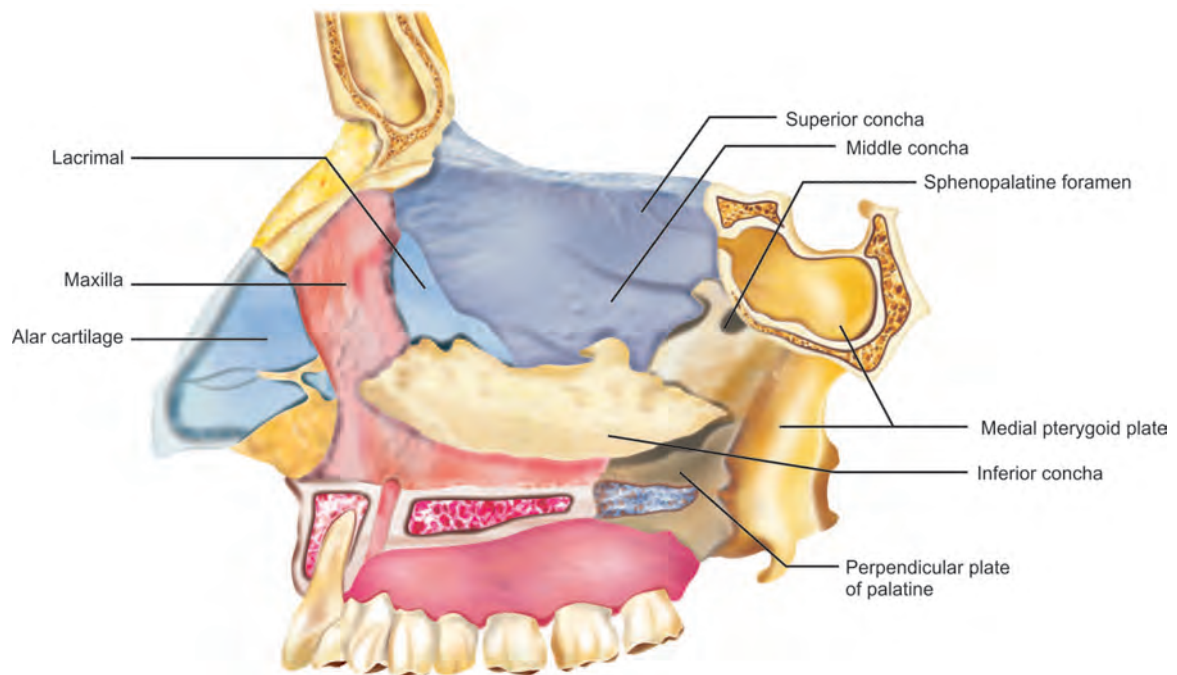


FIGURE 68 Lateral wall of nose

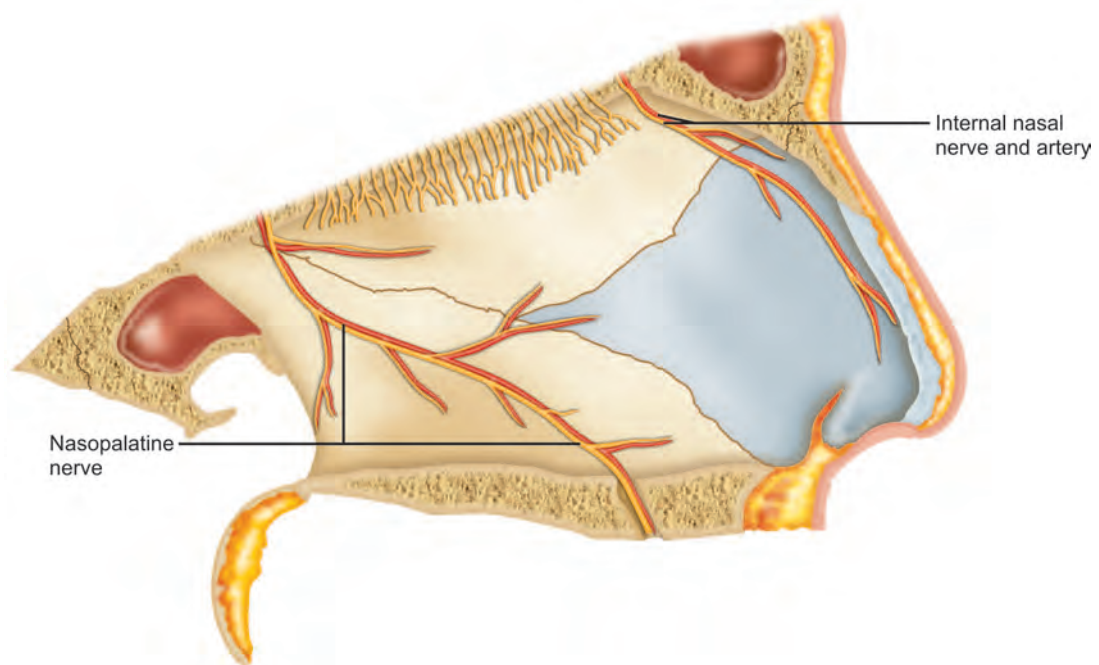


FIGURE 69 Vessels and nerves of nasal septum

LATERAL WALL OF NOSE (Fig. 70)

Vestibule: It is the depressed area immediately internal to the anterior nasal aperture. Note the small thick hairs called vibrissae. The vestibule is bounded superiorly by the *limen nasi*. The area above the limen is the *atrium*. It is limited superiorly by *agger nasi* an elevation. The atrium lies continuous with the middle meatus.

Conchae: These are the bony elevations seen in the lateral wall. They are generally three in number—the *superior, middle* and *inferior conchae*. The superior and middle are projections of the ethmoid bone and the inferior is an individual bone. Put a fine forceps and identify the gaps, the meatuses. The nasal cavity is surrounded by air sinuses, superiorly, posteriorly and laterally. These sinuses open into the meatuses. Feel the thick membrane covering the conchae. These are cavernous in nature, i.e. they are filled with capillary plexus.

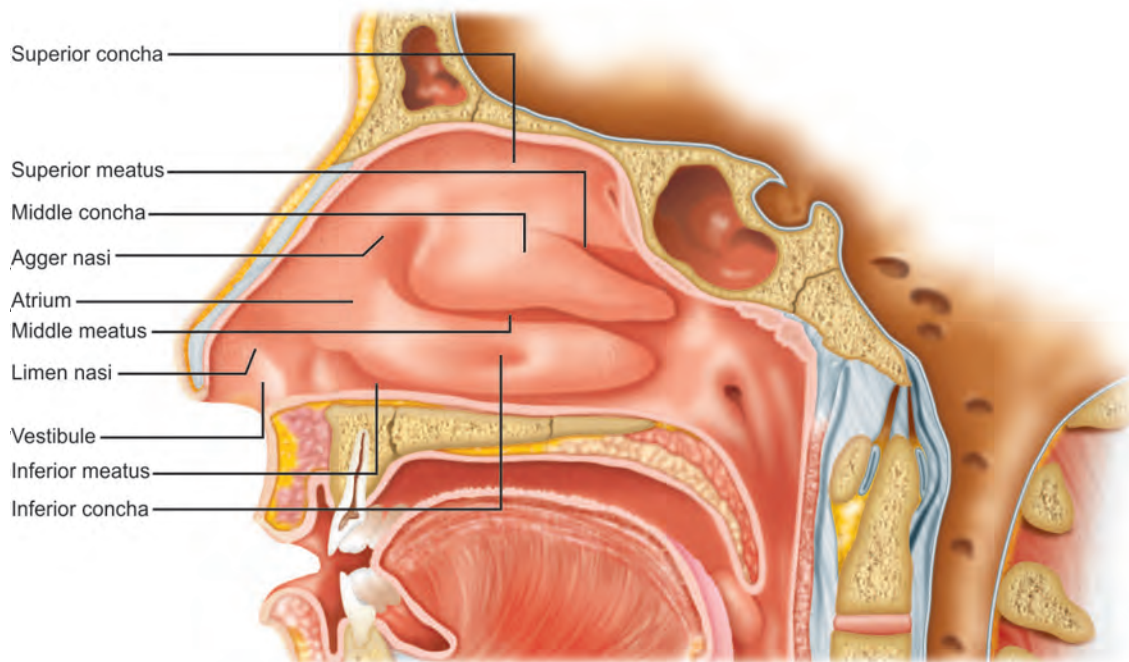


FIGURE 70 Lateral wall of nose

PTERYGOPALATINE GANGLION (Fig. 71)

Dissection: Strip the mucoperiosteum behind the conchae and locate the pterygopalatine fossa. Locate the thick maxillary nerve and study the pterygopalatine ganglion.

Pterygopalatine ganglion is a parasympathetic ganglion. It is connected to the maxillary nerve by two roots. It carries both general sensory fibres and secretomotor fibres. See the two roots and the pterygopalatine ganglion hanging down from the **maxillary nerve**. Trace the **nerve of the pterygoid canal** entering into the ganglion. These carry the preganglionic secretomotor fibres. Trace the branches arising from the pterygopalatine ganglion. The **greater and lesser palatine** nerves descend down and reach the roof of the palate. The **pharyngeal branch** goes posteriorly, the **nasal branches** traverse forward and **nasopalatine nerve** crosses and reaches the septum.

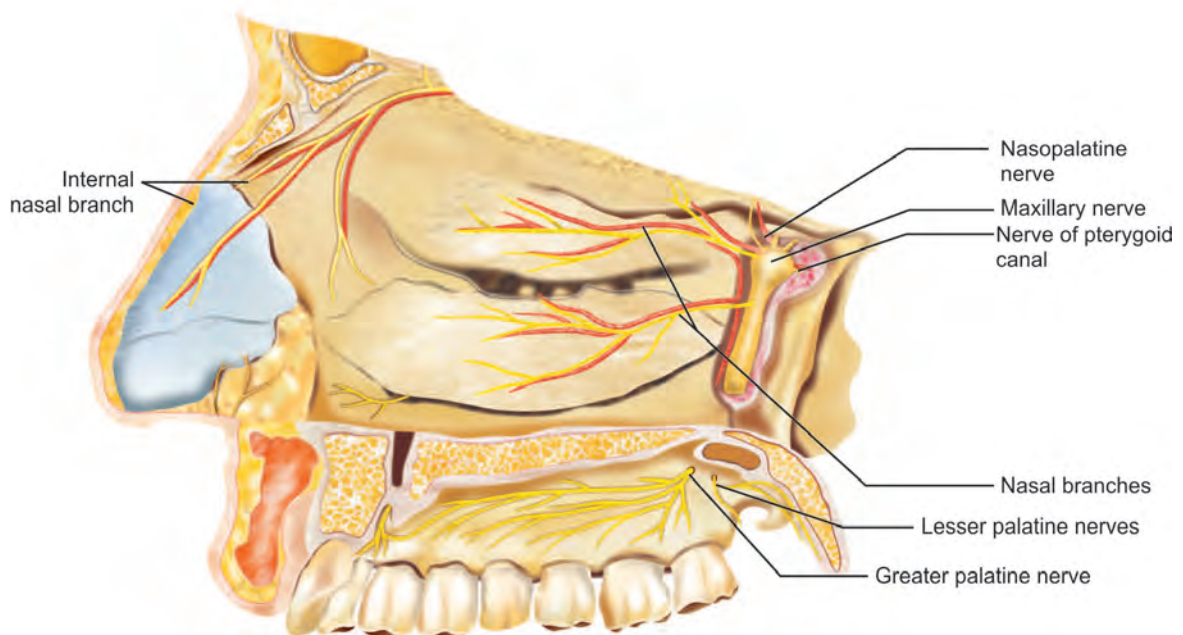


FIGURE 71 Pterygopalatine ganglion

MAXILLARY NERVE (Fig. 72)

Dissection: Turn the part to the outer side, and break the bone of the middle cranial fossa with a bone forceps. Identify the maxillary nerve in the middle cranial fossa near the cavernous sinus.

The **maxillary nerve** reaches the pterygopalatine fossa through the foramen rotundum. It moves forward into the floor of the orbit. See the **posterior superior alveolar nerves** that it gives off before reaching the orbit. They supply the maxillary teeth and the maxillary air sinus.

Arterial supply is by **maxillary artery**. The third part of the maxillary artery reaches the pterygopalatine fossa after passing through the infratemporal fossa. It accompanies the maxillary nerve in the pterygopalatine fossa. It continues as the infraorbital artery in the floor of the orbit. Locate this artery and its branches in the pterygopalatine fossa. It gives off **posterior superior alveolar, greater palatine, lesser palatine, nasopalatine, pharyngeal and artery accompanying the nerve of the pterygoid canal**. Study of air sinuses and meatuses.

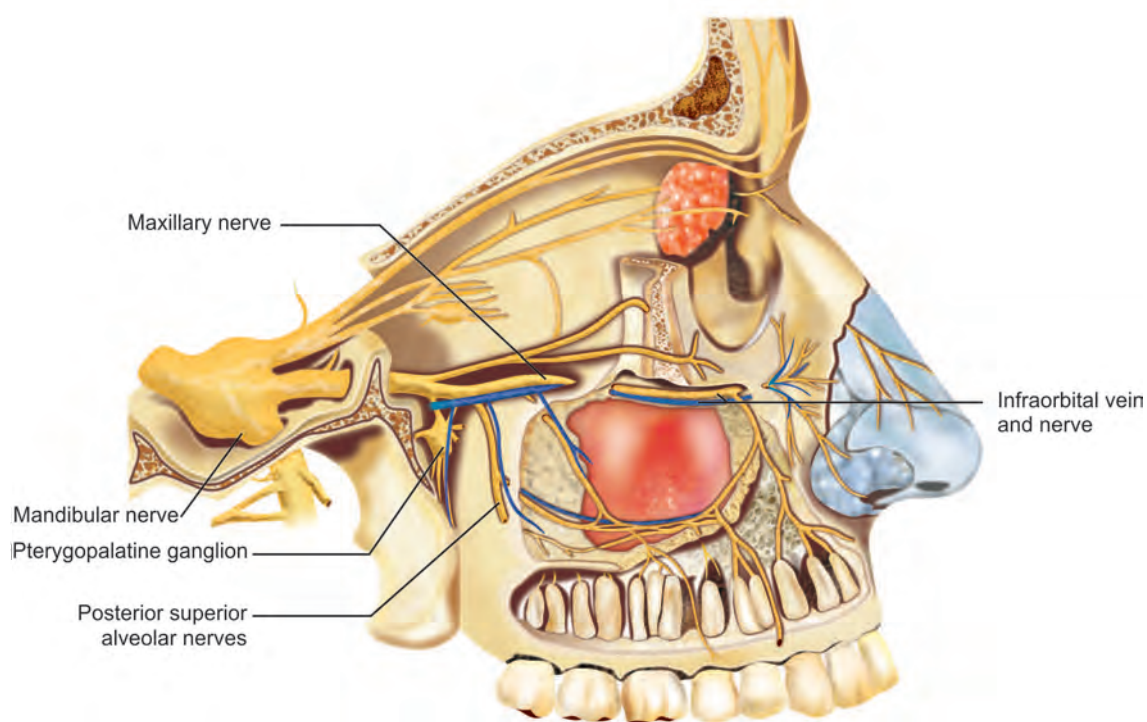


FIGURE 72 Maxillary nerve

STUDY OF AIR SINUSES AND MEATUSES (Fig. 73)

Dissection: Cut the conchae with a scissors near their attachment.

Sphenoethmoidal recess: This is the space above and posterior to the superior concha. The *sphenoidal air sinus* opens into this. Locate this in the body of the sphenoid bone. It is divided into two halves by an unequal septum. Pass a probe from the sinus to the sphenoethmoidal recess.

Superior meatus: Identify this deep to the superior concha. The *posterior ethmoidal air cells* open into this. Cut the superior concha with a scissors. Note that two to three air cells open into it. Put a probe into them and note that they belong to posterior group of ethmoidal air cells. There are around 8 to 10 cells on the ethmoid bone. They are grouped into posterior middle and anterior group.

Middle meatus: It is the space deeper to the middle concha. Cut the middle concha with a scissors very near its attachment. Note the *bullae ethmoidalis*. It is a bulge in the center of the meatus. Note 2 to 3 air cells opening into it. Put a probe through them and note they are in the center of the ethmoid bone. These are *middle ethmoidal air cells*. Identify the groove below the bullae ethmoidalis. This is the *hiatus semilunaris*. It receives *frontal, ethmoidal* and *maxillary air sinuses*.

Put a probe into the anterior end of the hiatus and push it up and note that they are continuous with the air cells in the anterior part of the ethmoid through a small infundibulum. These are the *anterior ethmoidal air cells*.

Frontal air sinus: Put another probe through the cut frontal air sinus into the anterior end of the hiatus semilunaris through the infundibulum.

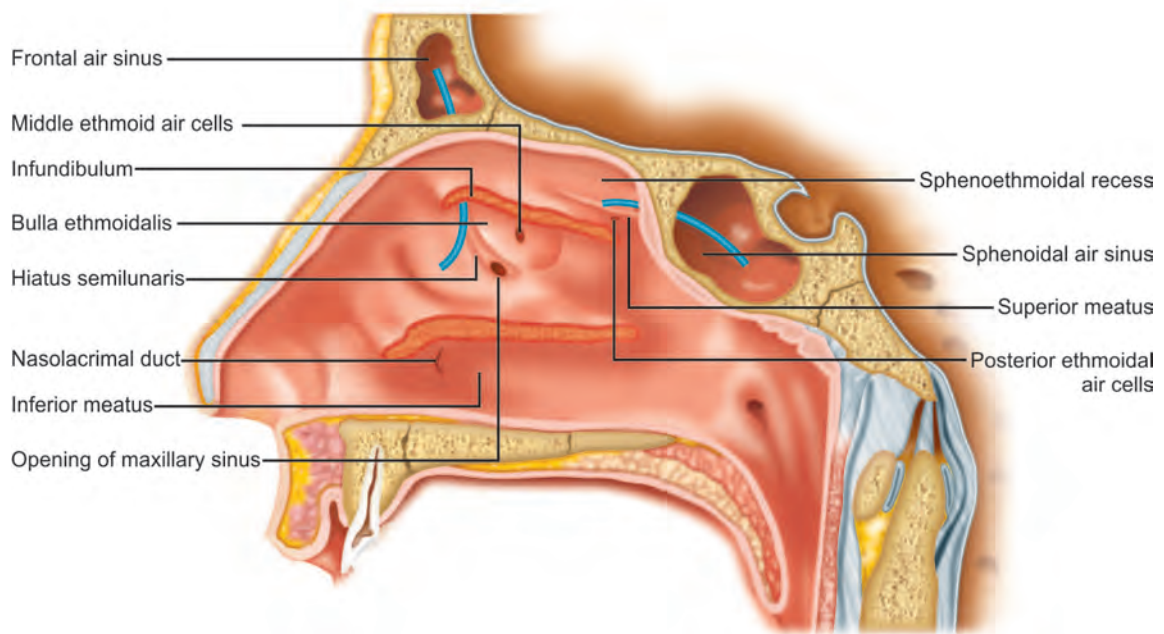


FIGURE 73 Meatuses and air sinuses

Maxillary air sinus: It occupies the whole maxilla (identify this on a dry skull. Identify its opening in the floor of the hiatus semilunaris. Pass a probe downwards and note its depth. Note that the rear premolars and molars project into it). Realize the mechanical disadvantage of this sinus, as its opening is above the base, due to this, the maxillary air sinus gets often infected.

Inferior meatus: Note that it is widest of all meatuses. It receives the *nasolacrimal duct*. It is nearer to the anterior end of the meatus. Pass a fine probe into the nasolacrimal duct. It passes through the bony wall to reach the lacrimal sac in the medial end of the orbit. Feel the lacrimal sac.

Neurovascular bundle of the nasal cavity: Nasal cavity is supplied by the branches of the maxillary nerve and maxillary artery. They reach the nasal cavity through the pterygopalatine fossa.

PALATE (Figs 74 and 75)

The palate is made up of hard palate and soft palate. The hard palate separates the nasal cavity from the oral cavity. The soft palate separates the nasopharynx from the oropharynx. The midline posterior projection from the soft palate is called the uvula.

Hard palate: It is made up of bones. Identify the bones forming the hard palate on a dry skull. They are maxilla and the palatine bone.

Dissection: Strip the mucus membrane from the hard palate and identify the greater and lesser palatine vessels and nerves reaching here through the foraminae of the same name. They are branches of the maxillary nerve through the pterygopalatine ganglion. They are both sensory as well as secretomotor to the hard palate.

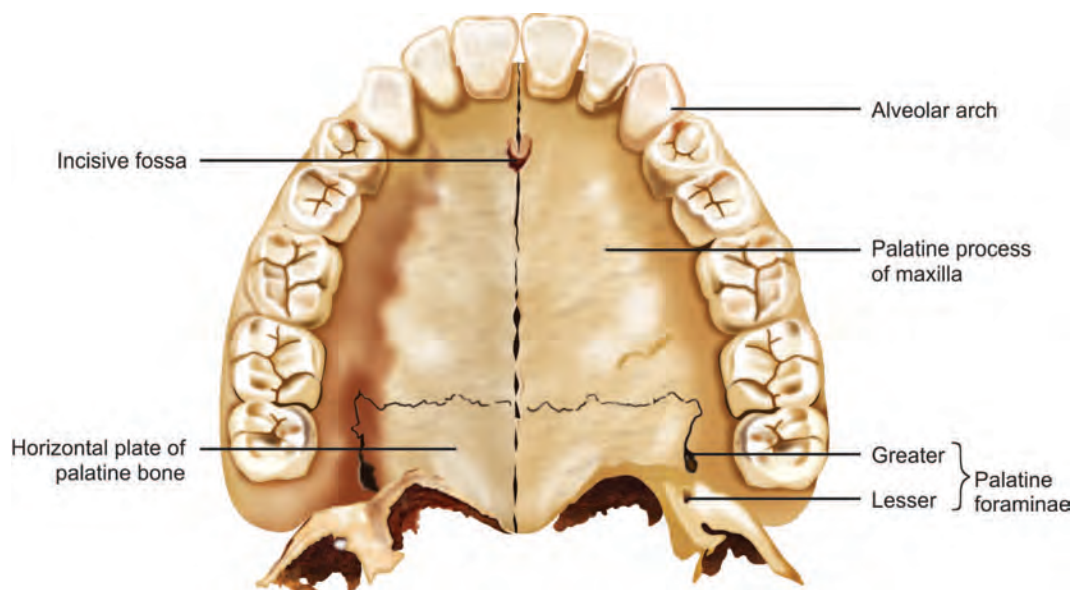


FIGURE 74 Bony hard palate

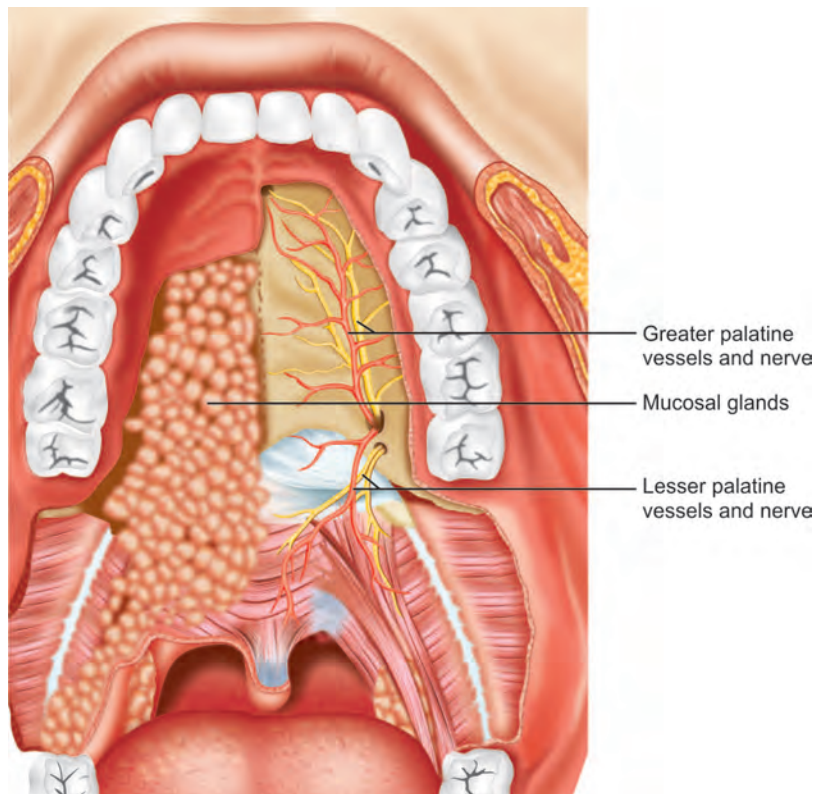


FIGURE 75 Hard palate



MOUTH

The mouth has two parts—the vestibule and the oral cavity. The vestibule lies external to the teeth and the oral cavity lies between the maxilla and mandible. The partition between the nasal cavity and oral cavity is formed by the hard palate. The oral cavity lodges the tongue.

Vestibule (Fig. 76): This is the area between the cheeks laterally and maxilla and mandible medially. The parotid duct opens into it opposite to the upper second molar tooth. If possible try to locate its end (this can be seen well in a living subject).

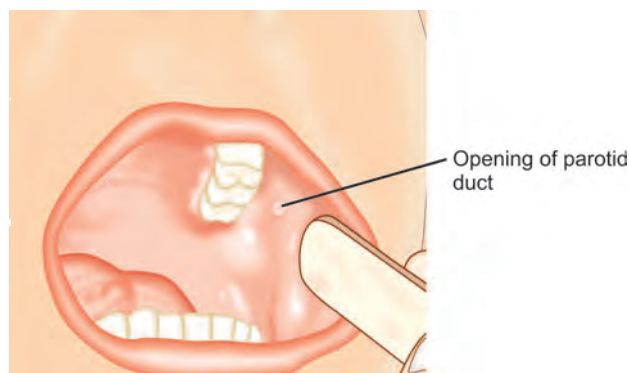


FIGURE 76 Vestibule

TONGUE (Figs 77 and 78)

Dorsum of the tongue is the superior surface facing the hard palate (See all the parts in a living person also). Note the **sulcus terminalis** near the posterior part. It is a V shaped sulcus which separates the anterior 2/3rd from posterior 1/3rd. In the anterior 2/3 note the fine **filiform papillae**.

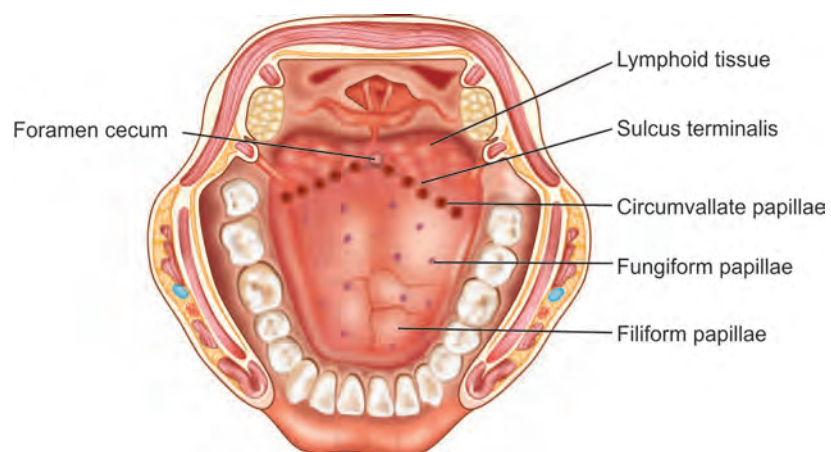


FIGURE 77 Dorsum of tongue

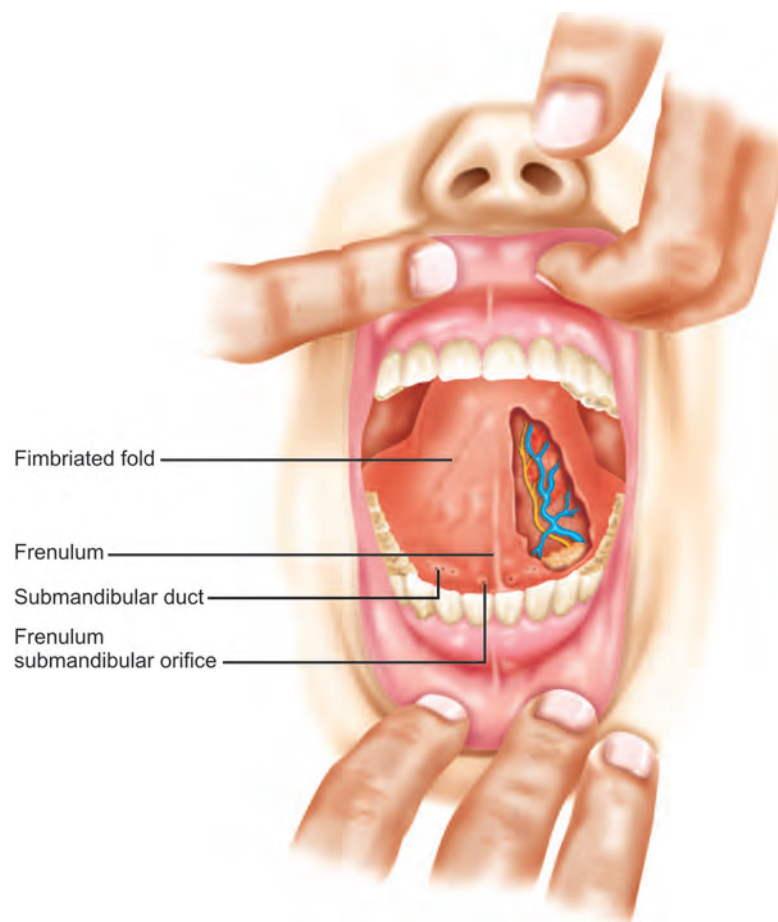


FIGURE 78 Ventral surface of tongue

See the rounded **fungiform papillae** between the filiform papillae. Locate the **circumvallate papillae** behind the sulcus. In the remaining part of the posterior 1/3—note the grooves. These grooves receive the openings of the deeply placed glands. The elevations between the grooves is due to the lymphoid tissue.

Ventral surface of tongue: Lift the tongue up and note the **frenulum in the midline**, **fimbriated fold** laterally and **sublingual fold** and **orifice of the submandibular duct** in the floor (see these in a living person).

MUSCLES OF TONGUE (Fig. 79)

Muscles of tongue can be divided into intrinsic and extrinsic muscles. The muscles are bilateral and are separated by a central fibrous septum. The intrinsic muscles have no bony attachment.

In a paramedian section of the tongue the intrinsic muscles can be identified. They are arranged as: **Superior longitudinal layer** lies immediately beneath the dorsum of the tongue. **Vertical muscle fibres** run down vertically. **Horizontal fibres** intermingle with the vertical fibres. **Inferior longitudinal fibres** lie below these above muscles.

Genioglossus: This is the extrinsic muscle from the superior genial tubercle lies between the inferior longitudinal fibres and genial tubercles. This is a fan-shaped muscle. It is a depressor of the tongue (other extrinsic muscles will be seen in a later dissection).

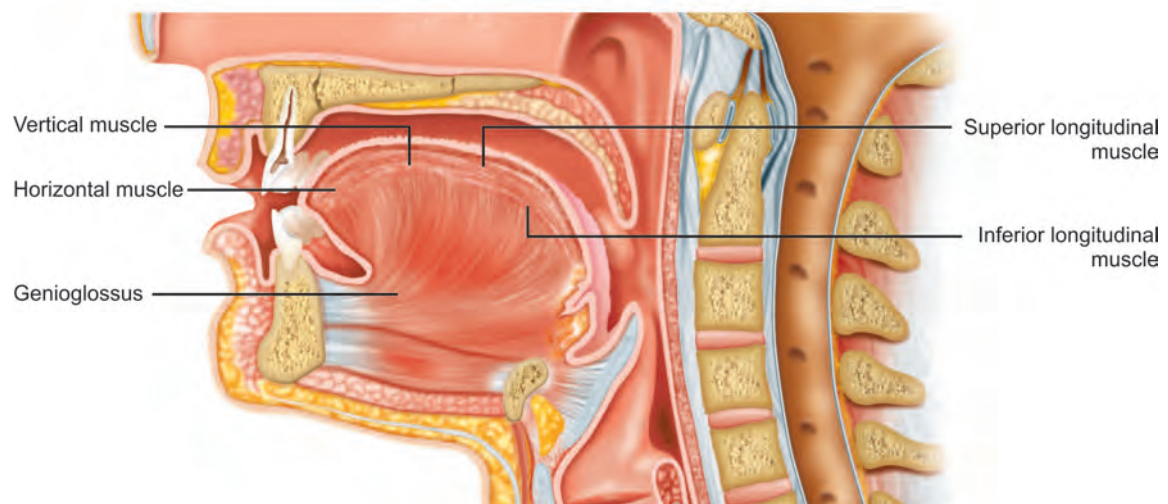


FIGURE 79 Intrinsic musculature of tongue

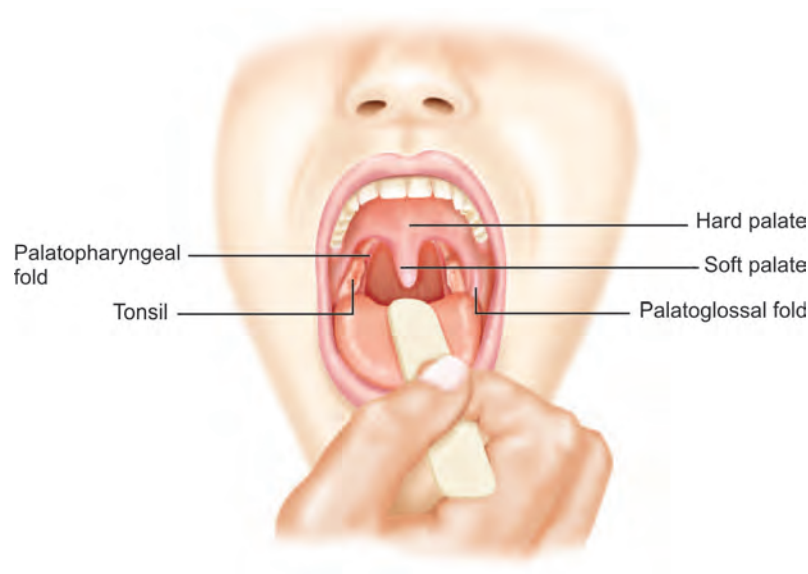


FIGURE 80 Fauces

Fauces (Fig. 80): It is the junction between the oral cavity and the oropharynx. It is formed by two pillars—the anterior palatoglossal fold and posterior palatopharyngeal fold. Between the two pillars the palatine tonsil is located.

PHARYNX

The pharynx is a funnel shaped fibromuscular tube extending from the base of the skull to the 6th cervical vertebra. It is divided into three parts—the nasopharynx, oropharynx and laryngopharynx (Fig. 81).

Boundaries: The roof of *nasopharynx* is formed by the sphenoid bone. It is continuous with the nasal cavity anteriorly. The junction is called the choanae. The lateral wall shows the auditory opening. Inferiorly and anteriorly it is separated from the oral cavity by the soft palate. Posteriorly and inferiorly it is continuous with the oropharynx. The roof of the *oropharynx* is same as the floor of the nasopharynx. Oropharynx is continuous with the oral cavity anteriorly and superiorly. Anteriorly and inferiorly the sloping posterior 1/3rd of tongue forms the boundary. The junction between the oropharynx and oral cavity is called the oropharyngeal isthmus. It is formed by the palatoglossal fold. The lateral wall forms fauces and lodges tonsil. The *laryngopharynx* is continuous with the larynx anteriorly. The opening into the larynx is called inlet of the larynx. The laryngopharynx lies behind and parallel with the larynx. It continues below as the esophagus.

It is the common passage for air and food. Its interior is covered by mucous membrane. Structurally, the pharynx has four layers. Innermost mucosal layer, followed by submucosal layer, the external muscular layer, covered by adventitial layer.

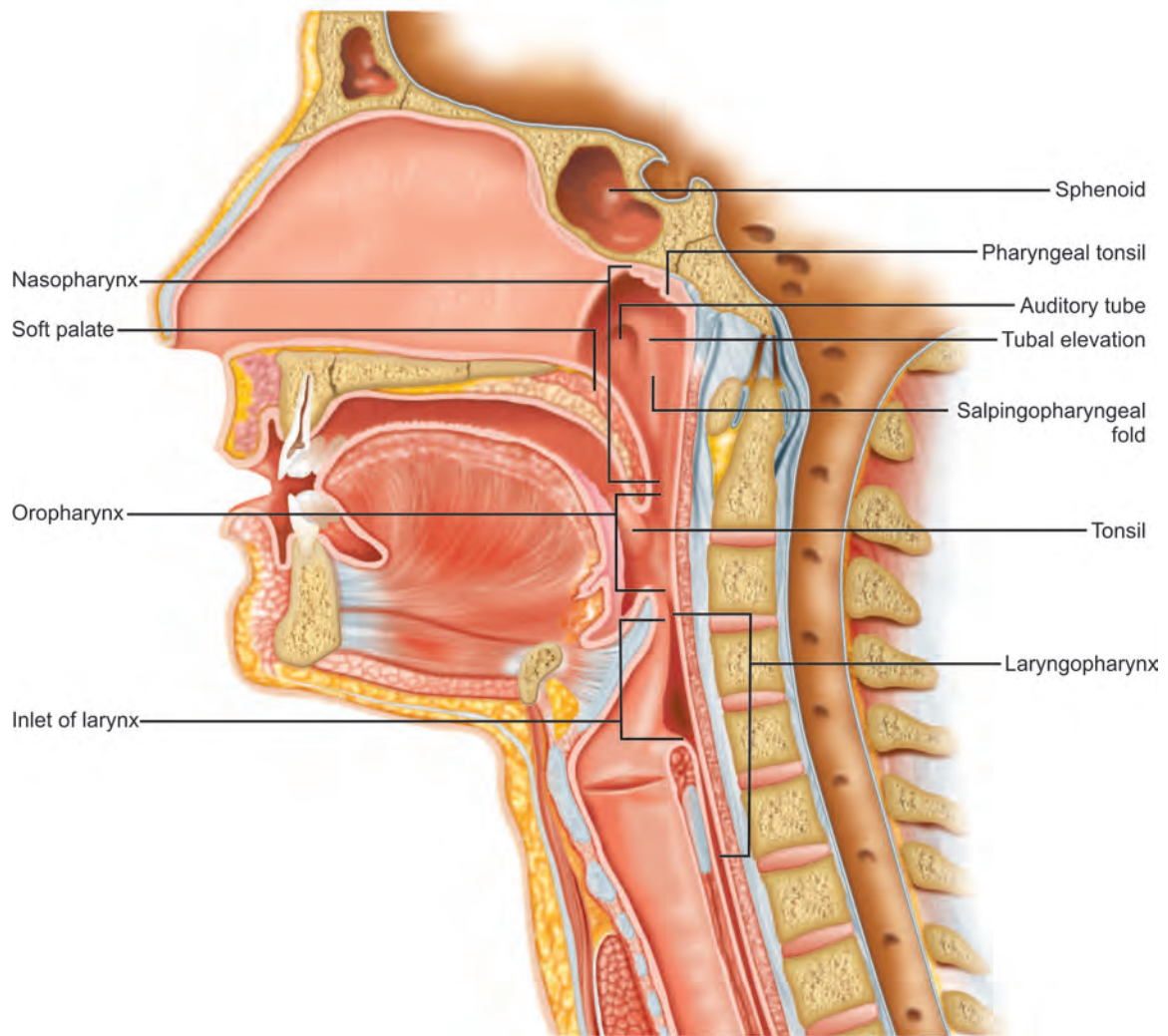


FIGURE 81 Interior of pharynx

Dissection: In this study from the interior you will see the mucous membrane, the submucosal lymphoid tissue and the inner longitudinal layer of the musculature. You will identify the lymphoid tissue as bulges. You need to strip the mucous membrane to identify the musculature.

Nasopharynx: See the position of the *pharyngeal tonsil*. It is the collection of lymphoid tissue in the roof of the pharynx. It can easily be identified deeper to the mucous membrane. Identify the *opening of the auditory tube* in the lateral wall. It is a longitudinal slit with anterior and posterior walls. The posterior wall is more prominent and is called *tubal elevation*. It is due to tubal tonsil, the aggregation of the lymphoid tissue here. A mucosal fold continues down from the tubal elevation and is called the *salpingopharyngeal fold*. The fold is raised by the salpingopharyngeal muscle.

SOFT PALATE (Fig. 82)

Soft palate is the posterior part of the palate and it is muscular. It is made up of five muscles. Two muscles can be seen from above and two muscles from below and one muscle posteriorly.

Dissection: Strip the nasopharynx mucous membrane.

Tensor veli palatine: Identify this muscle lateral and anterior to the auditory tube. It runs vertically on the external side of the auditory tube. It arises from the scaphoid fossa lateral side of auditory tube and spine of the sphenoid (identify them on the dry skull). It hooks round the pterygoid hamulus and gets inserted in the form of an aponeurosis which forms the core for the soft palate. It is a tensor of the soft palate. Nerve supply. It is supplied by the mandibular near trunk just below the foramen ovale (this was identified in the infratemporal fossa dissection).

Dissection: Pass a probe through the auditory tube. The muscle in front of it is the tensor veli palatine and the muscle behind it is the levator veli palatine.

Levator veli palatine: It arises from the undersurface of the petrous part of the temporal bone and the medial surface of the cartilage of the auditory tube. It is inserted into the superior surface of the palatine aponeurosis. It is an elevator of the palate.

Musculus uvulae: Strip the mucous membrane over the uvula and locate this centrally located muscle. It arises from the spine and gets into the mucous membrane.

Salpingopharyngeus: This muscle is the longitudinal muscle of the pharynx. It arises from the lower part of the auditory tube and is inserted into the posterior border of thyroid cartilage. Pull the muscle up and feel the insertion and its action as an elevator of larynx.

Dissection: Strip the mucous membrane of the oropharynx and see the musculature.

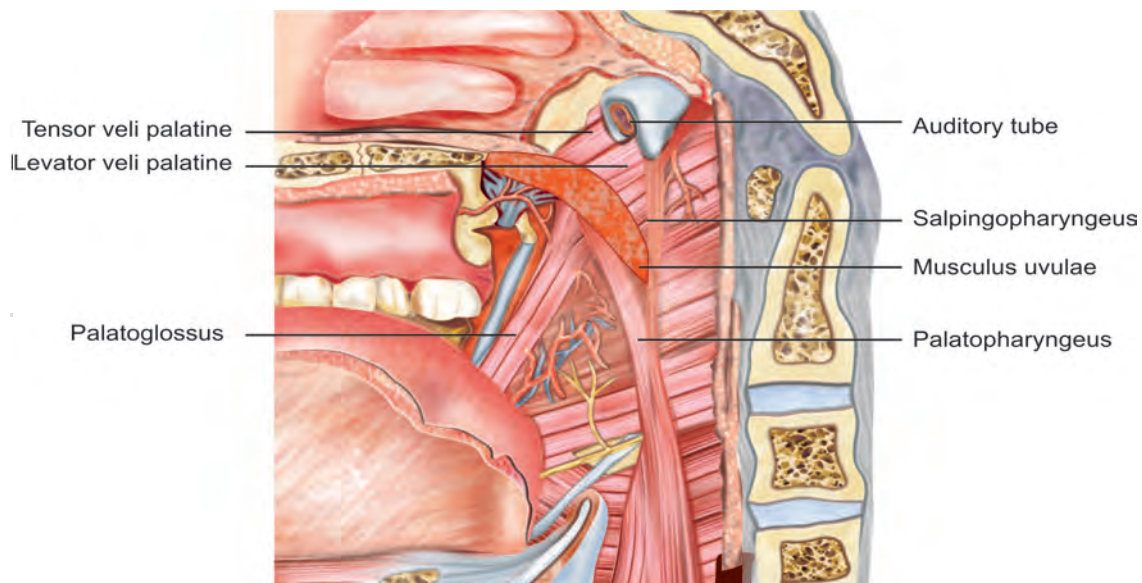


FIGURE 82 Soft palate

Palatoglossus muscle: This muscle forms the anterior pillar of the fauces. This is an extrinsic muscle of the tongue arising from the soft palate. It arises from the undersurface of the palatine aponeurosis. It is inserted into the side of the tongue.

Palatopharyngeus muscle. This muscle forms the posterior pillar of the fauces. It arises from the posterior border of the hard palate and the palatine aponeurosis. It runs downwards and is inserted into posterior border of the thyroid cartilage. This is also an elevator of the larynx.

Passavant's muscle: Few of the fibres of the palatopharyngeus muscle run straight back to the midline raising an elevation in the lateral wall. It acts like a sphincter between nasal and oral pharynx, along with the soft palate.

Nerve supply: All the muscles of the pharynx and the soft palate are supplied by the cranial accessory nerve through the pharyngeal plexus located in the pharyngeal wall except the tensor veli palatine which is supplied by the mandibular nerve.

Tonsil: Note this lymphoid tissue between the palatoglossal and palatopharyngeal fold. It shows pitted appearance.

OROPHARYNX (Fig. 83)

Anteroinferior wall of the oropharynx: This is formed by the posterior part of tongue. Note the following structures by pushing the tongue forwards.

Median glossoepiglottic fold: It is a raised mucosal fold in the midline extending from the back of the tongue to the center of the epiglottis.

Lateral glossoepiglottic folds: These are two lateral mucosal folds to the right and left of the median fold.

Vallecula: It is the central depression between the median and lateral glossoepiglottic folds.

Laryngopharynx It coexists with the larynx, in other words, the larynx forms the anterior wall to this part of the pharynx (this will be studied with larynx).

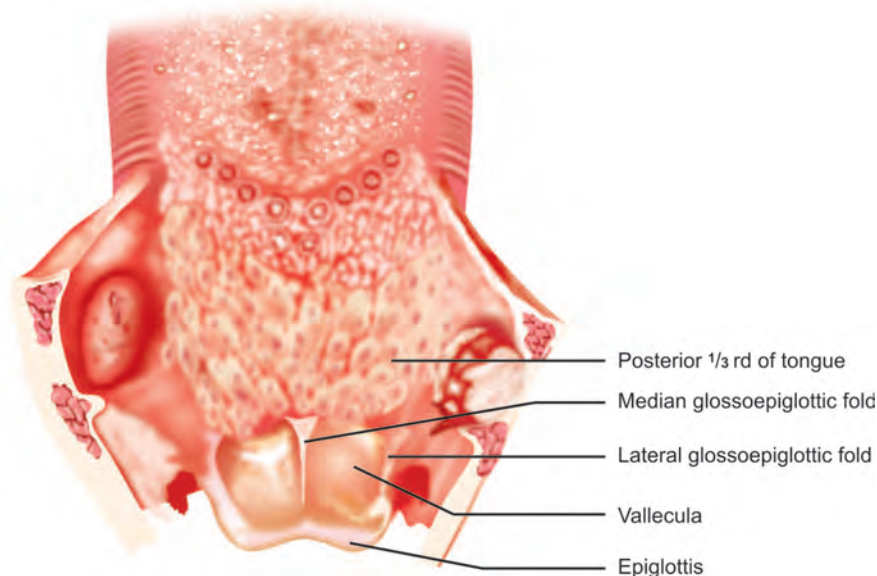


FIGURE 83 Anteroinferior wall of oropharynx

STUDY OF THE STRUCTURES FROM THE LATERAL ASPECT (Fig. 84)

The pharynx extends from the basiocciput to the 6th cervical vertebra. It is covered by adventitial layer. Clean this connective tissue and try to identify the following structures from above downwards on the lateral aspect. This is the external circular muscular layer. It is made up of three muscles one fitting into the other, like buckets.

Superior constrictor muscle: It is the upper circular muscle of the pharynx. Identify the muscle. It arises from the medial pterygoid plate, pterygomandibular raphe and mandible behind the third molar tooth. At its upper border identifies the anterior tensor veli palatini and posterior levator veli palatini with the auditor tube in between.

Middle constrictor muscle: Locate this muscle lying deeper to the hyoglossus. It arises from greater, lesser cornu of the hyoid bone and the lower part of the stylohyoid ligament. The fibres span out posteriorly to reach the midline.

Inferior constrictor muscle: Note this muscle below and external to the middle constrictor. It arises from the oblique line of thyroid cartilage and from the lateral side of the cricoid cartilage. It is Inserted into the midline raphe located posteriorly.

All the three constrictors of pharynx insert into a median raphe posteriorly. They are supplied by cranial accessory nerve through the pharyngeal plexus.

Dissection: Peel the connective tissue from the posterior aspect of the pharyngeal musculature. Try to identify as many nerve branches as possible.

Pharyngeal plexus: It is a plexus of nerves deep to the pharyngeal fascia. It is formed by the (i) pharyngeal branch of the vagus, but it carries the cranial accessory fibres. Thus it receives through a communication near the jugular foramen. These fibres supply the muscles of pharynx and soft palate. (ii) Pharyngeal branch of glossopharyngeal nerve. It is sensory to the mucous membrane. (iii) pharyngeal branch of superior cervical sympathetic ganglion. This carries vasomotor fibres to the blood vessels of the pharynx.

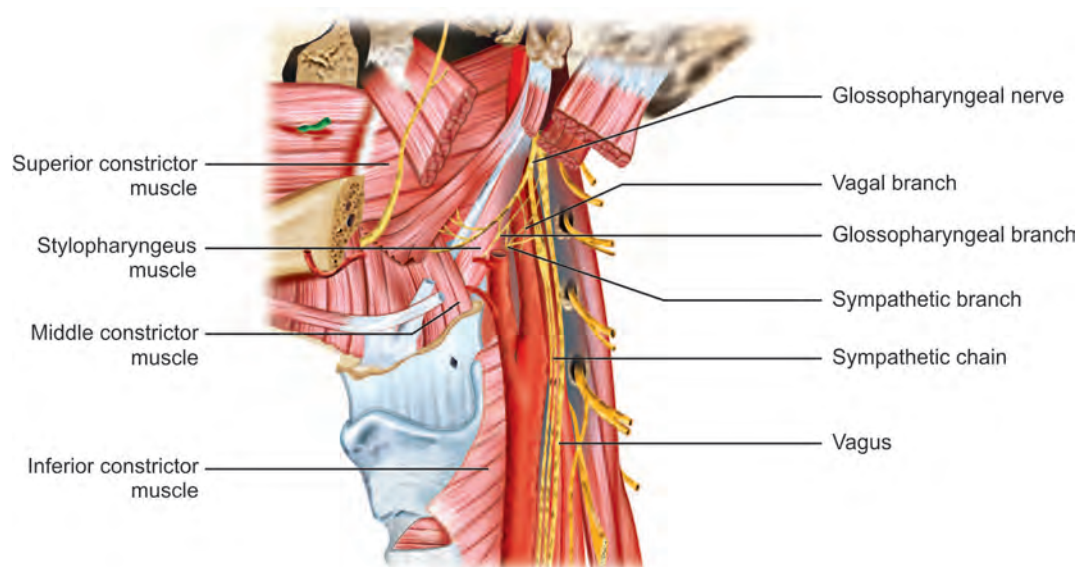


FIGURE 84 Structures from the lateral aspect

LARYNX

Larynx is an organ of voice production. It extends from the 4th to 6th cervical vertebrae. It is around 5 cm long, 4 cm in width and 3.5 cm in anterior posterior diameter. It is a fibrocartilaginous structure. It has an obliquely placed inlet of the larynx. It opens into the pharynx.

NEUROVASCULAR BUNDLE (Fig. 85)

Dissection: Reidentify the neurovascular bundle entering into the larynx before taking it out of the body.

Internal laryngeal nerve and superior laryngeal vessels: These enter the larynx through the thyrohyoid membrane. Superior laryngeal artery is a branch of superior thyroid and nerve is a branch of superior laryngeal nerve. This nerve is sensory above the rima glottidis. External laryngeal nerve is a branch of the superior laryngeal, branch of the vagus nerve.

Inferior laryngeal artery and the recurrent laryngeal nerve: Trace these two structures entering into the larynx between trachea and esophagus below the inferior constrictor muscle. The recurrent

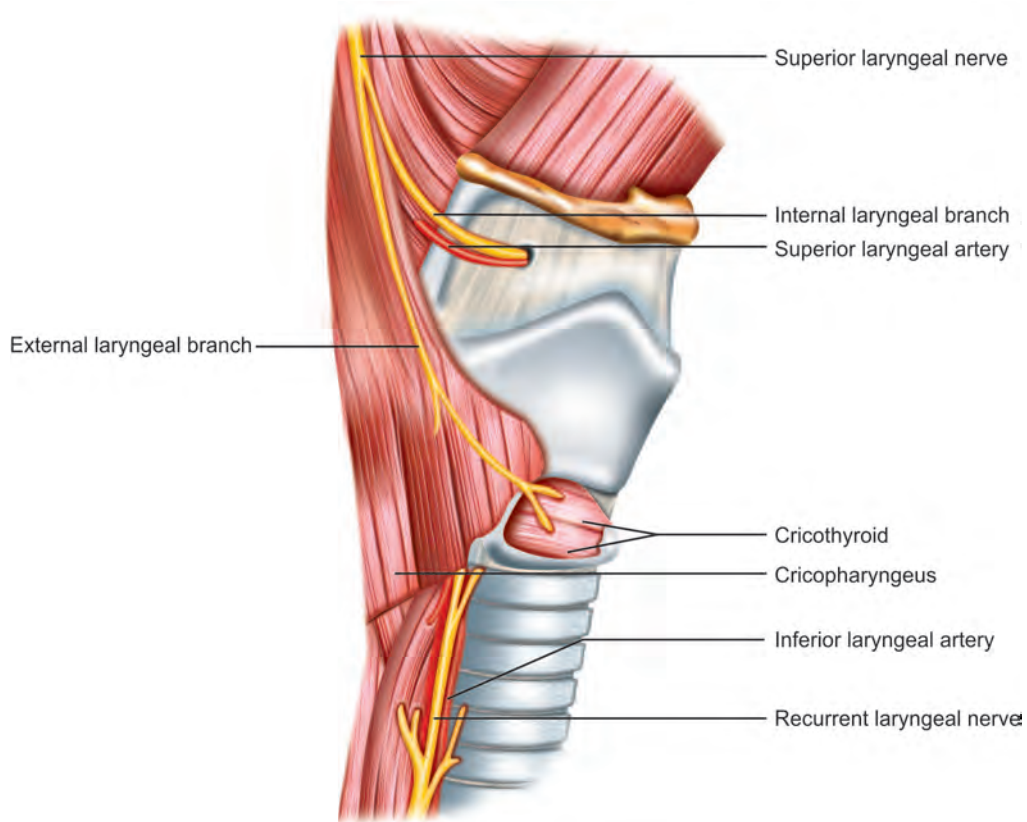


FIGURE 85 Larynx—neurovascular bundle

laryngeal nerve is a motor nerve to muscles of larynx and sensory to mucous membrane below the rima glottidis.

Dissection: Remove the larynx from the body (where it is not bisected in a sagittal plane) by cutting it above the hyoid bone, and the sides of the pharyngeal wall and clean the fascia. Inferiorly cut it near the 3rd tracheal ring. Feel the following cartilages, bones and membranes.

SKELETON OF LARYNX (Figs 86 and 87)

Hyoid bone: This forms the superior boundary of the larynx. It has got a wide body in the center, greater cornua extending laterally and lesser cornua at the junction of body and greater cornua.

Thyrohyoid membrane: Identify this membrane extending between the upper border of hyoid bone to the upper border of thyroid cartilage. It shows two thickenings medial (in the midline) and lateral (towards the ends) thyrohyoid ligaments.

Thyroid cartilage: This cartilage has two laminae. They unite anteriorly in the midline to form an angle. This is called Adams apple or laryngeal prominence. It is around 90° degrees in males and 120° in females. It has two horns, the superior and inferior horns. The inferior horn articulates with the cricoid cartilage.

Cricothyroid ligament: Feel this ligament between the thyroid and cricoid cartilage on the anterolateral aspect. Push the back of the forceps and note that it is attached to the inner aspect of the thyroid cartilage near its middle.

Cricoid cartilage: Feel the broad posterior lamina of the cricoid cartilage and the anterior arch shaped part. Totally it resembles a signet ring.

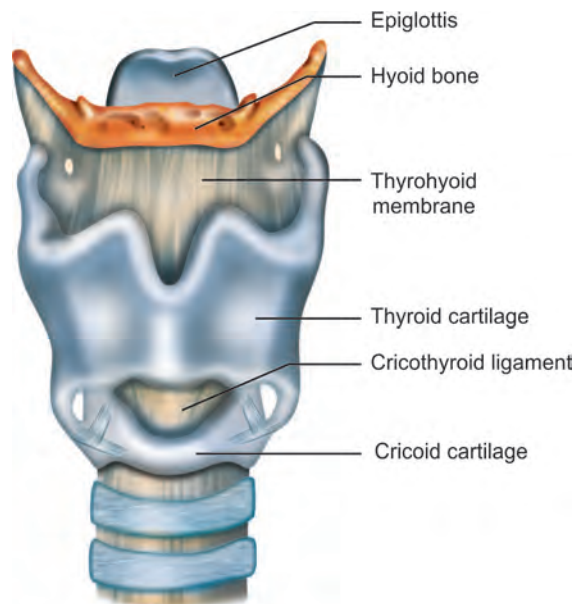


FIGURE 86 Skeleton of larynx—anterior view

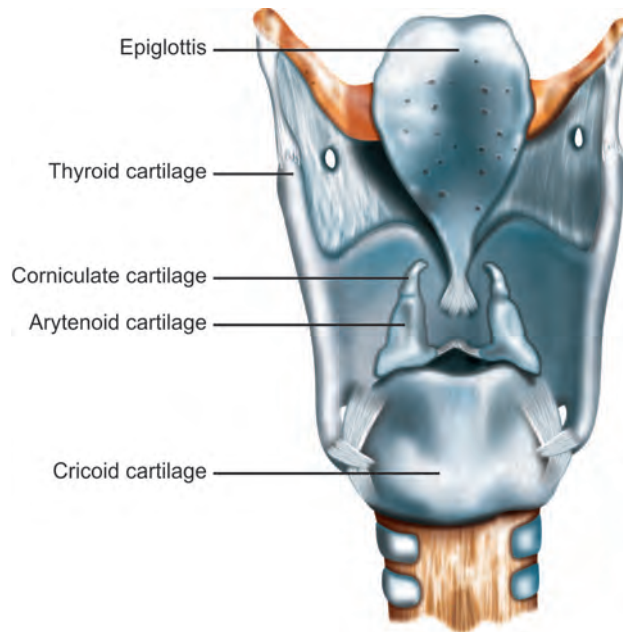


FIGURE 87 Skeleton of larynx—posterior view

Arytenoid cartilages: Feel these pyramidal shaped cartilages on the superior surface of the cricoid cartilages. Feel its three surfaces, the medial, lateral and the base. It has three angles, the superior (articulating with corniculate cartilage), the anterior is called vocal process and lateral is called muscular process.

Corniculate cartilage: It is a comma shaped cartilage articulating with the superior angle of arytenoid.

Cuneiform cartilage: Feel it. It is a nodule in the aryepiglottic fold.

Epiglottis: Identify this leaf shaped cartilage on the posterior aspect of the hyoid and thyroid cartilages. It can easily be bent forwards and backwards. It is connected to the hyoid by hyoepiglottic ligament and to the thyroid by thyroepiglottic ligament.

Quadrangular membrane: You clasp this membrane between your fingers. It extends from the anterior border of the arytenoid cartilage to the side of the epiglottis. As the name signifies it is quadrangular in shape. It has a superior border called aryepiglottic ligament. This forms part of inlet of larynx. Its inferior free border forms the vestibular ligament. The quadrangular membrane separates the vestibule of the larynx from the piriform fossa, the space between the larynx and the thyroid cartilage.

INLET OF LARYNX

Turn the larynx to its posterior aspect and observe and feel the inlet of the larynx. It is formed by the upper border of the epiglottis, aryepiglottic folds, arytenoids cartilages and interarytenoid mucous membrane.

Dissection: Peel the adventitial layer from the outer surface of the larynx and identify the muscles.

MUSCLES (Fig. 88)

Posterior cricoarytenoid: Identify this muscle on the posterior aspect of the lamina of cricoid cartilage. It arises from the same and is inserted into the muscular process of the arytenoids cartilage. Note that the fibres are transverse in the upper part, these act as lateral rotators, and the lower fibres slope up, and these would pull the arytenoid downward thus producing abduction.

Oblique arytenoid: See it between the two arytenoids. It arises from the posterior aspect of one arytenoid and is inserted into the apex of the other arytenoid. Note that the fibres of both sides cross each other like an x. It acts along with aryepiglottic muscle to close the inlet of the larynx.

Transverse arytenoid: This muscle is deeper to the oblique arytenoid. It extends from one arytenoids to the other arytenoid. This muscle acts as an adductor.

Aryepiglottic muscle: Trace this muscle in the free margin of aryepiglottic fold. It arises from the apex of the arytenoids to be inserted into the side of the epiglottis. The aryepiglottis along with the oblique arytenoid acts like a scissors and closes the inlet of the larynx.

Cricothyroid: See this on the lateral aspect. It arises from the lateral aspect of the cricoid cartilage and is inserted into the lower border of the thyroid cartilage. It is a tensor of the vocal cords. It is supplied by the external laryngeal nerve.

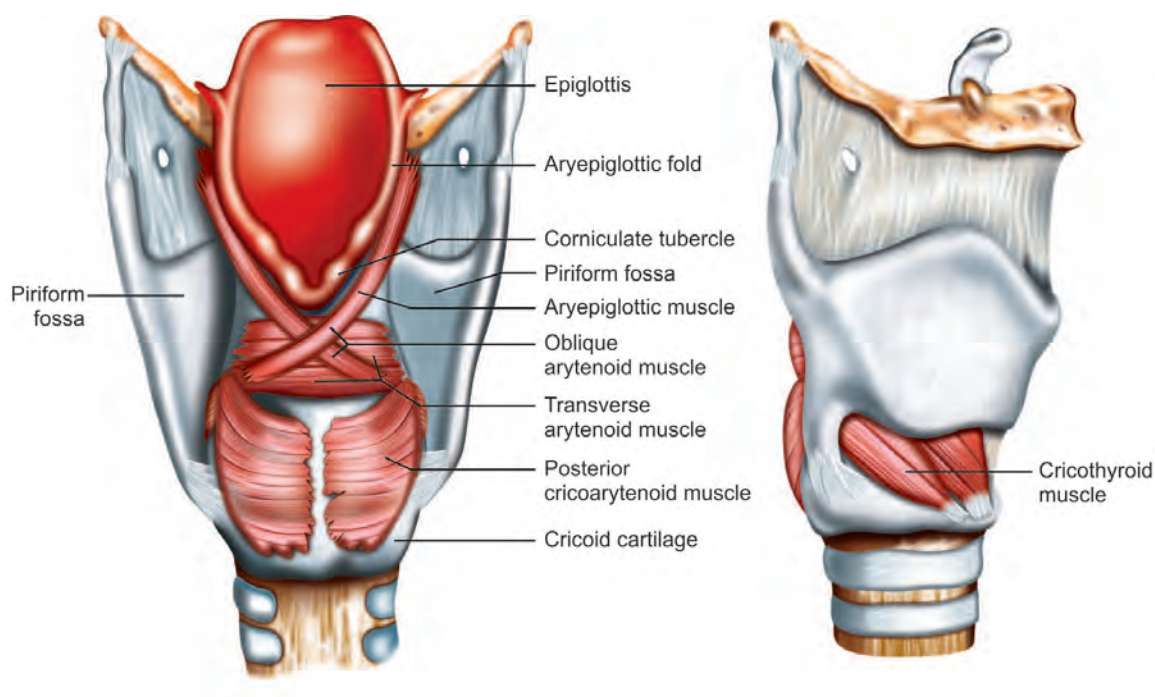


FIGURE 88 Muscles of larynx

Lateral cricoarytenoid muscle (Fig. 89): Trace this deeper muscle. It arises from the upper border of the cricoid cartilage. It is inserted into the muscular process. It is an abductor of vocal cords.

Dissection: Cut the posterior wall of larynx in the midline and open it. See the interior.

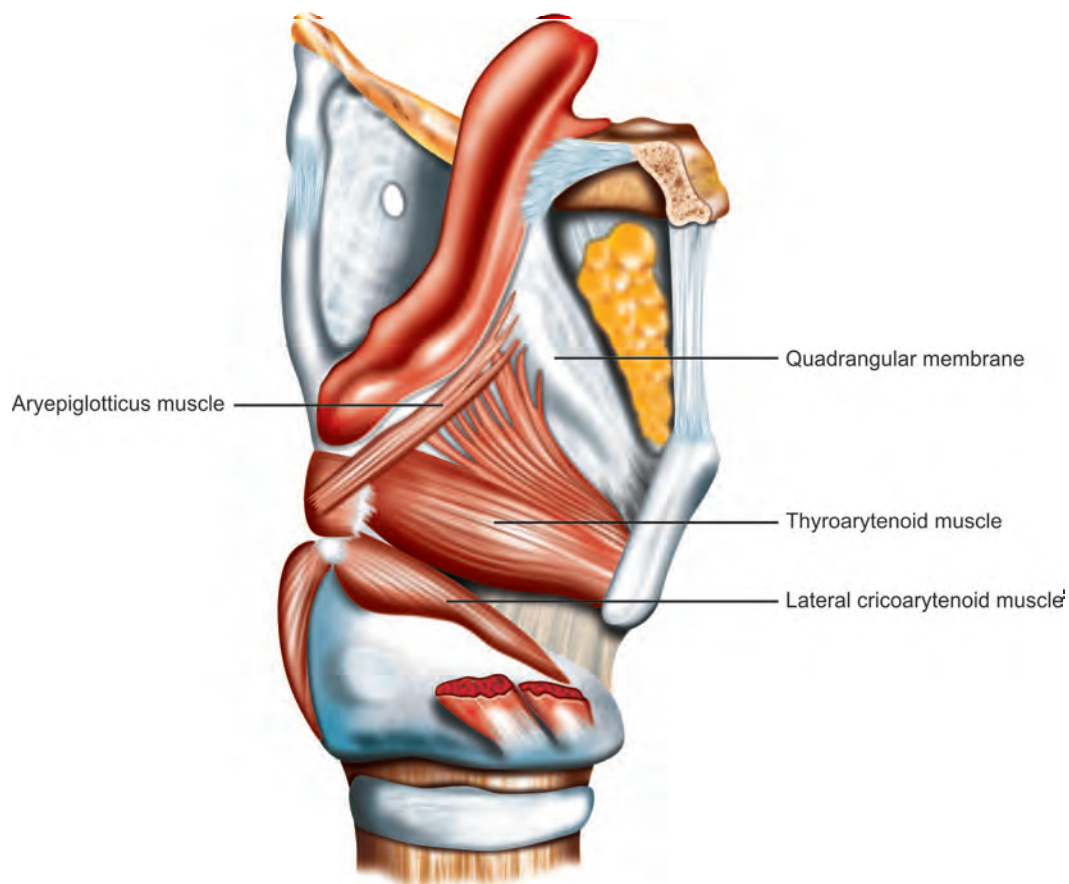


FIGURE 89 Deep muscles of larynx

INTERIOR OF LARYNX (Fig. 90)

Rima vestibuli: It is the lower border of the quadrangular membrane. It is thickened at its lower part and is called vestibular ligament. It is covered by mucous membrane called vestibular folds. The gap between the two vestibular folds is called the rima vestibuli.

Rima glottidis: It is the gap between the two vocal ligaments. The thickened upper end of the cricothyroid membrane is called the vocal ligament. The mucous membrane covering it forms the vocal fold. The gap extending from the back of the thyroid cartilage to the posterior wall is called the rima glottidis. It has got an anterior intermembranous part and posterior intercartilaginous part between the two arytenoid cartilages.

Sinus: It is the gap between the rima vestibuli and rima glottidis.

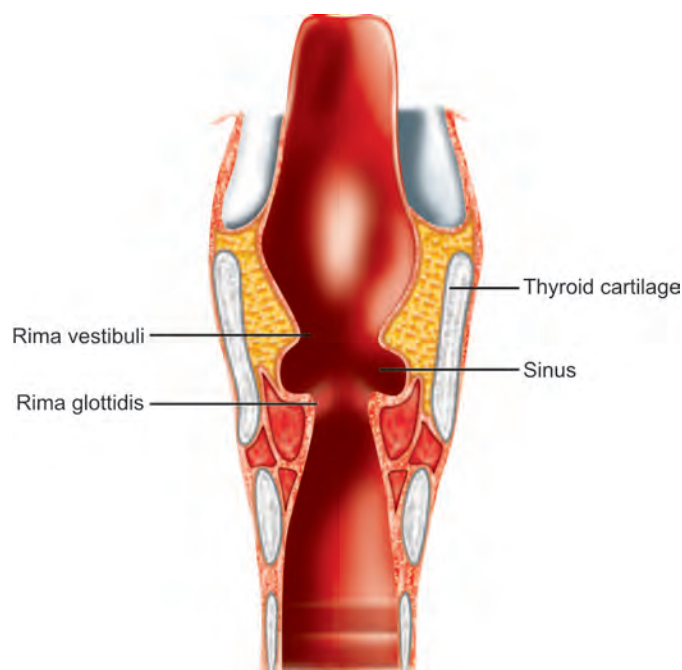


FIGURE 90 Interior of larynx

Saccule: Put a probe through the sinus and extend it upwards. This is an extension of the sinus lateral to the quadrangular membrane. In birds it is very much well developed.

Vestibule: It is the part of the larynx, above the rima vestibuli to the inlet of the larynx. See its anterior wall, is far higher and formed by the epiglottis.



EYEBALL (Figs 91 and 92)

Dissection: It is easy to study bull's eye as they are big in size and well developed. Clean the muscles on the external surface. Take two eyeballs cut one along the equator in a coronal section dividing it into anterior and posterior halves, the other anteroposteriorly into two halves. See the following.

Cornea: Cornea is the outer protective coat. It forms the anterior 1/6th of the outer coat of the eyeball. It is transparent.

Sclera: It forms the posterior 5/6th of the outer coat of the eyeball. It is the opaque thick fibrous layer.

Vitreous body: This is the innermost jelly like body. It is enclosed by a thin capsule. It generally gets cut and falls off when the eyeball is cut.

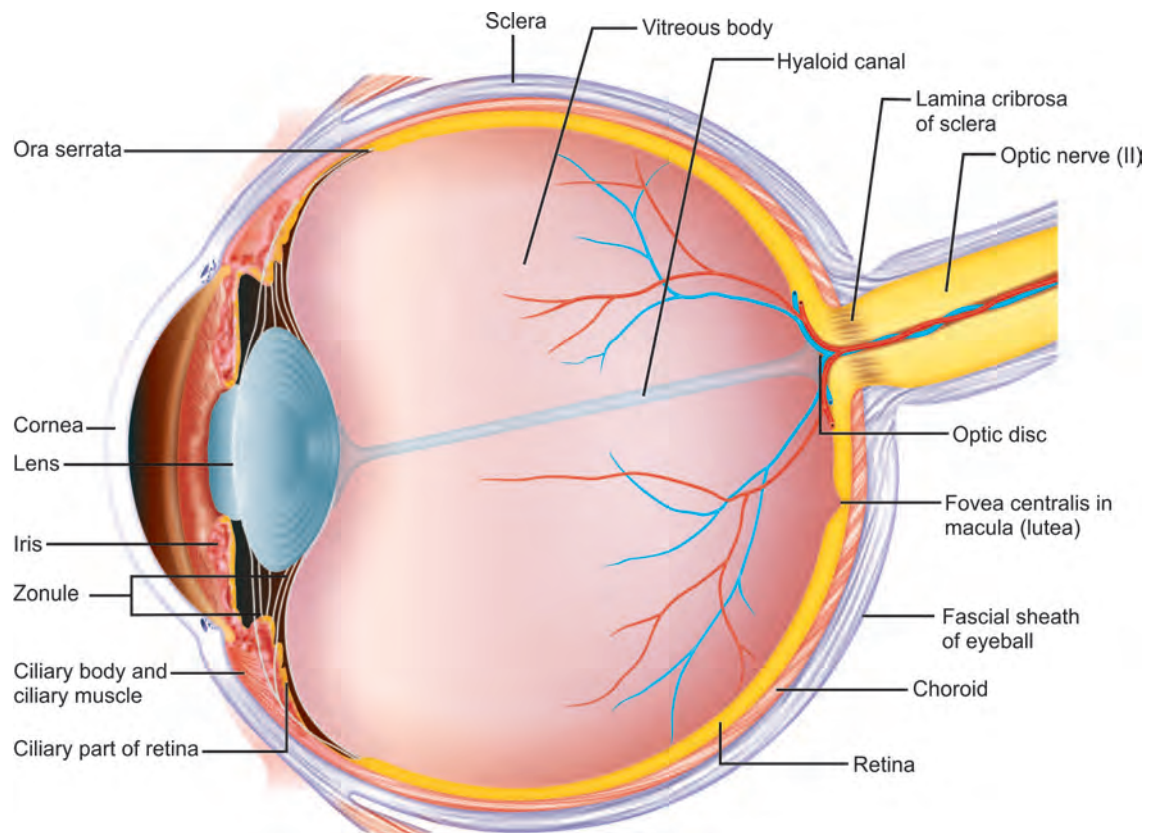


FIGURE 91 Sagittal section of eyeball

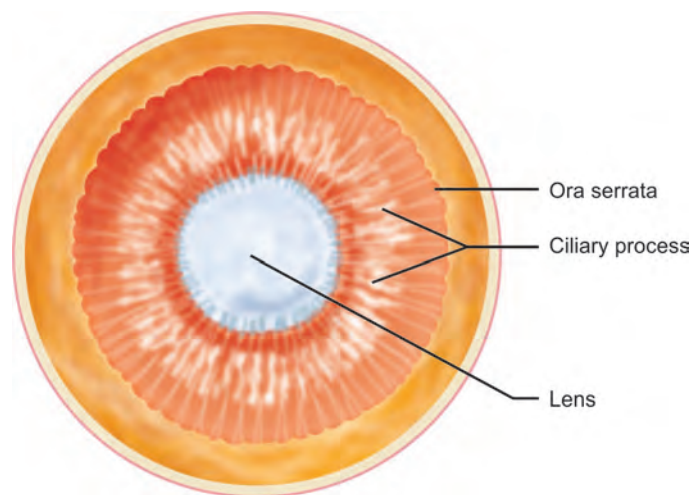


FIGURE 92 Coronal section of eyeball

Retina: This is the nervous layer of the eye. It looks whitish in the cut eyeball. It easily gets peeled off from the deeper choroid layer. It becomes very thin anteriorly.

Vascular layer: It is the intermediate layer. Peel the retinal layer and look at this layer. It is black in color. **Iris** is its anterior part and this lies in front of the lens. **Ciliary body**—this is the part lateral to the lens. **Choroid**—this is the part behind the ora serrata. **Ora serrata**—is the serrated junction between the ciliary body and choroid. This can easily be identified.

Zonule: Note this suspending fibrous structure extending from the ciliary body to the lens.

Lens: This is the biconvex structure suspended by the zonular fibres.

MUSCLES OF THE EYEBALL

Ciliary muscle: Locate this muscle within the ciliary body.

The sphincter and dilator pupillae: These are the muscles present within the iris. You can see these muscles in the cut parts of the ciliary body and iris. These muscles are supplied by the autonomic nervous system, through the ciliary ganglion.

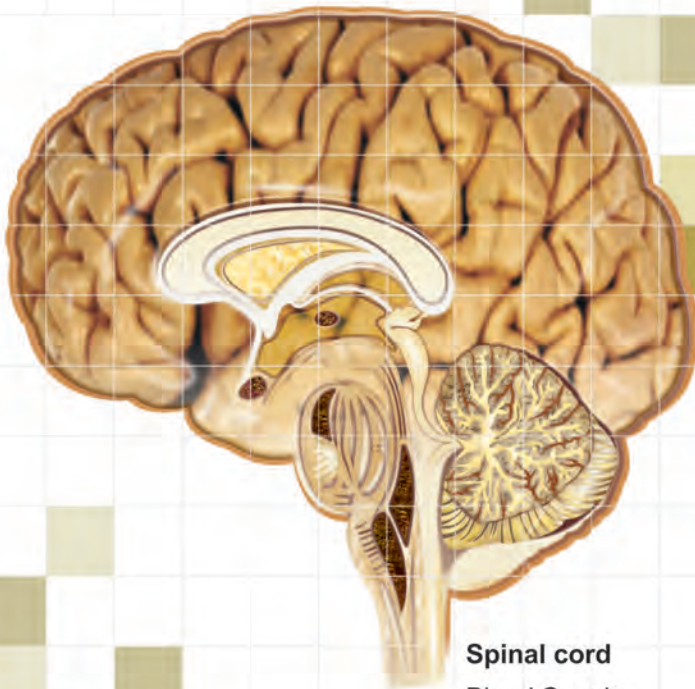
Optic disc and optic nerve: Identify these structures at the posterior medial part of the eyeball.

Anterior ciliary arteries: These arteries enter the sclera near the sclerocorneal junction. The posterior ciliary arteries pierce the sclera around the optic nerve. All the arteries are branches of the ophthalmic artery.

Venae vorticosae: These are the veins draining the eyeball. They pierce the eyeball near the equator and drain into ophthalmic veins.

■ CHAPTER 2

CENTRAL NERVOUS SYSTEM



Spinal cord

Blood Supply
External Features
Internal Structure

Brain

External Features
Brainstem
Cerebellum
Fourth Ventricle

Sections of Brainstem

Forebrain

Cerebrum

Limbic System

White Matter of Cerebrum

Lateral Ventricle

Third Ventricle

Diencephalon

Sections of Forebrain

SPINAL CORD

You removed the spinal cord from the vertebral canal along with the meninges. Take out the detached preserved spinal cord and lay it on the table with the ventral surface facing you. The spinal cord is covered by meninges.

MENINGES: The spinal cord is covered by the thick outer *dura mater*. The *arachnoid mater* is thinner and lies inner to the dura mater. The dura and arachnoid are almost adherent in the cadaver. The space between them is a capillary subdural space.

Dissection: Slit through the dura, arachnoid by a longitudinal cut in the midline both from anterior as well as from the posterior part from the cervical level to the sacral level. Pull and see the arachnoid mater on the inner aspect of the dura mater.



BLOOD SUPPLY (Figs 1A and B)

The space between the arachnoid and pia mater is the subarachnoid space. It is filled with cerebrospinal fluid in the living. It lodges the blood vessels.

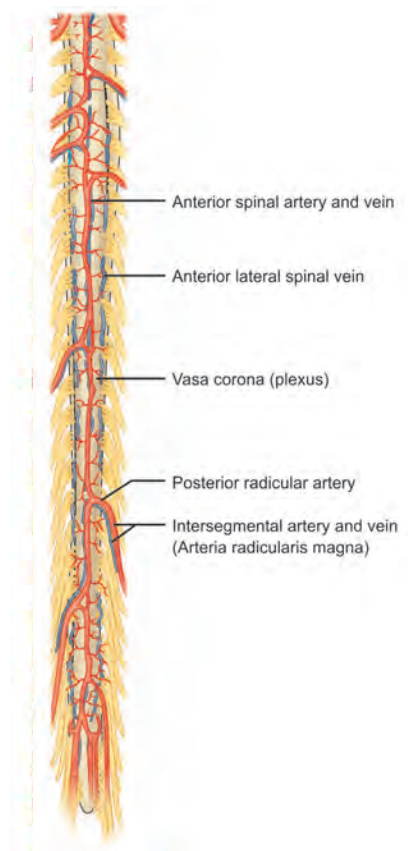


FIGURE 1A Blood supply of spinal cord—
anterior aspect

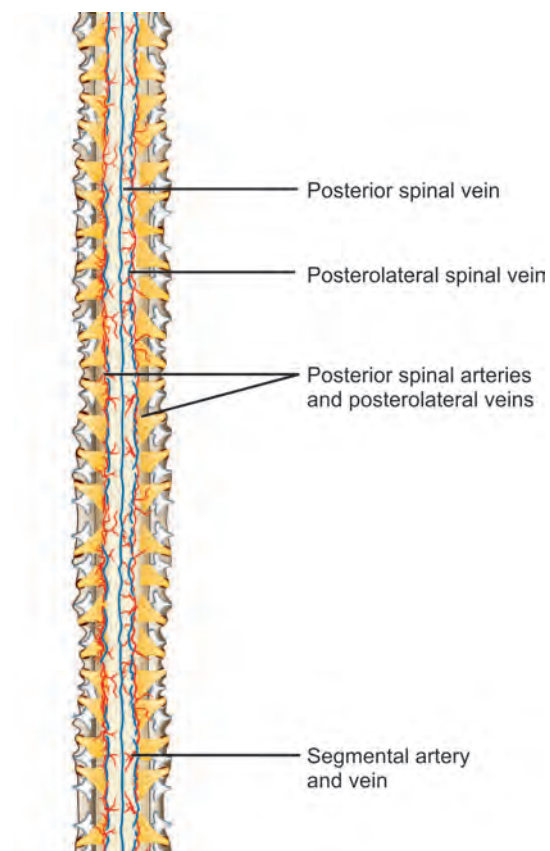


FIGURE 1B Blood supply of spinal cord—
posterior aspect

The spinal cord is supplied by vertebral arteries and intersegmental arteries. They lie in the subarachnoid space, anastomose and penetrate the pia mater to enter the substance of the spinal cord. Once they penetrate the nervous tissue they are end arteries. Accompanying veins drain into vertebral plexus of veins.

Dissection: Clean and identify the blood vessels. Note the anterior spinal artery ventrally in the midline. See the posterior spinal arteries near the dorsal roots. Identify six longitudinal venous channels, one each in the midline anteriorly and posteriorly, and four along the dorsal and ventral nerve roots.

Anterior spinal artery: It is formed by the union of medial branches of vertebral artery in the cranial cavity. This runs in the anterior median fissure. Here it gives off small branches which enter the white matter. In the lower levels it is supported by segmental arteries.

Posterior spinal arteries: These are two in number. These are lateral branches of vertebral arteries or inferior cerebellar arteries. They are given off in the cranial cavity. They run down from there along the dorsal nerve roots.

Segmental arteries: Identify them along with the nerves. They enter the vertebral canal through the intervertebral foramina. Trace them along the ventral and dorsal nerve rootlets. They divide and run transversely over the spinal cord and are called anterior and posterior radicular arteries. The segmental arteries are variable in number. Identify at least few of the arteries.

Vasa corona: These are fine circularly placed branches from the radicular arteries which form an interconnecting plexus.

Arteria radicularis magna: It is bigger in caliber and supplies the lower segments of the spinal cord. This varies in position. It may arise either from one of the lower thoracic segmental or upper lumbar segmental arteries.

The anterior spinal, posterior spinal and the vasa corona send central perpendicular branches to supply the substance. Once they enter the cord they are end arteries. Pull the arteries and identify these branches. Thrombosis in any of these vessels leads to insufficiency of blood and results in ischemia.

Veins of the spinal cord: They stand out because of their black coloration. They appear tortuous, and anastomose freely. Normally six longitudinal channels are easily identifiable. They are along the anterior median fissure, posterior median sulcus and along the four groups of nerve rootlets. They accompany the nerve roots and drain into the segmental veins.

Pia mater: This lies deeper and is adherent with the spinal cord. It is loose over the rootlets of the nerves and forms the ligamentum denticulata between the spinal nerves. They are generally 21 in number. They are tooth like processes and are attached to arachnoid and dura mater. The pia mater penetrates into the anterior median fissure of the spinal cord and is called the linea splendens. All the three meningeal layers continue on the outgoing spinal nerves and form a sheath over them.

Dissection: Clean the blood vessels and identify pia mater by pulling it on the surface of the spinal cord. Identify its extensions, the ligamenta denticulata. Put the pointed ends of the forceps near the points where the nerves are leaving the meninges and note that they are covered by the pia, arachnoid and dura mater. They gradually become continuous with the epineurium of the nerves. Trace the spinal nerves, pick them up nearer to the formation of the spinal nerve, trace it backwards to the spinal cord. Note that each spinal nerve enters the spinal cord as dorsal and ventral rootlets. Trace the spinal nerves down to the lower end. Note that these nerves are much longer in the lower part. This is due to the shortening of the spinal cord. At the lower end identify the aggregation of the spinal nerves, the cauda equina. Remove the pia mater and study the external features of the spinal cord.



EXTERNAL FEATURES (Figs 2 and 3)

The **spinal cord** is approximately 42-45 cm long. It is flattened anteroposteriorly.

It presents wide **enlargements** in the **cervical** and **lumbar** regions. This is due to the formation of nerve plexuses in these regions viz cervical, brachial and lumbosacral plexuses.

Conus medullaris: It is the cone like lower part of the spinal cord.

Filum terminale: This is the continuation of the pia and coccygeal nerve fibres. Identify this in the midline at the lower end of conus medullaris.

Cauda equina: Note this bunch of nerves extending from the lower part of the spinal cord to the lumbar, sacral, coccygeal intervertebral foraminae.

Anterior median fissure: It is a longitudinal ventral midline fissure which lodges the anterior spinal artery.

Anterolateral sulcus: Trace the ventral rootlets of the spinal nerves traversing this groove. Each spinal nerve has 6 to 8 rootlets leaving from here.

Posterolateral sulcus: Turn the cord posteriorly and identify this sulcus into which the posterior rootlets enter the spinal cord from the dorsal root ganglia. They may be 6 to 8 in number.

Posterior median sulcus: It is in the midline on the posterior aspect. The posterior spinal vein lies here.

SPINAL SEGMENT

Though spinal cord is continuous, looking at the attachment of the rootlets of the spinal nerve, a spinal segment can be determined. Note that the segments are longer in the cervical and thoracic level, whereas they are very short in lumbar and sacral segments. This is due to the shortening of the spinal cord due to its slower growth in comparison to the growth of the vertebral column. There are **32 spinal segments**. Each segment of the spinal cord supplies a body segment.

Each spinal segment functionally has two parts. The **sensory part**—receives sensations from the external and internal environment through the dorsal nerve roots. Once they enter the spinal cord the fibres are separated according to the sensations that they carry. They relay in different nuclei within the spinal cord. The second order neurons in this sensory pathway are sent to thalamus.

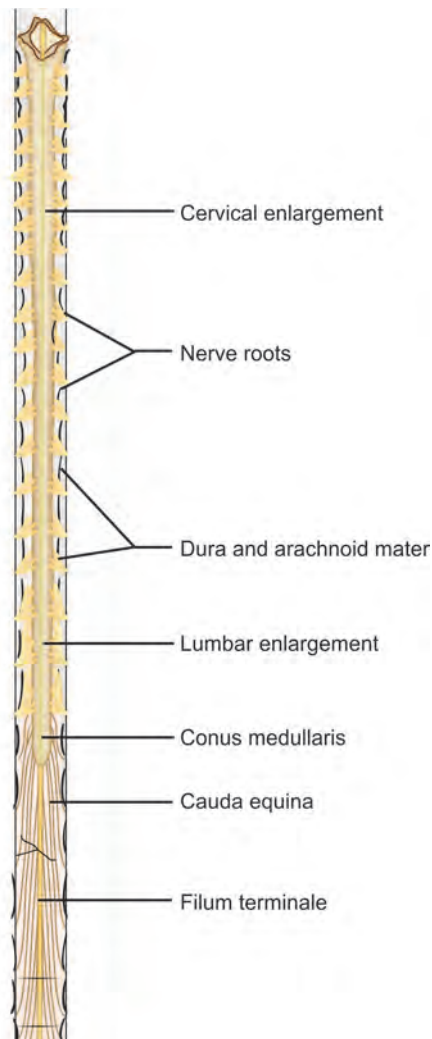


FIGURE 2 External features

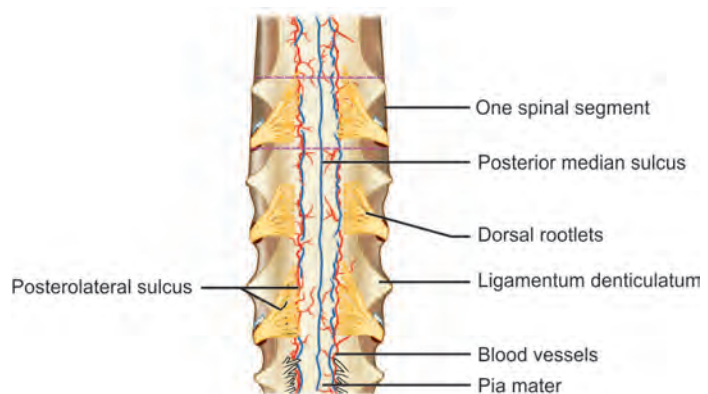


FIGURE 3 Segments of spinal cord—posterior view

The **motor part**—ventral roots carry the motor neurons. They reach the muscle of a particular segment and supply them. These motor fibres are controlled by the higher centers in the cerebral cortex.



INTERNAL STRUCTURE (Fig. 4)

The spinal cord structurally exhibits two parts, the **gray matter** and the **white matter**. The fibres which enter and leave the cord form the white matter. Group of fibres which perform a particular function occupy a particular position and are called tracts. They occupy a peripheral position and

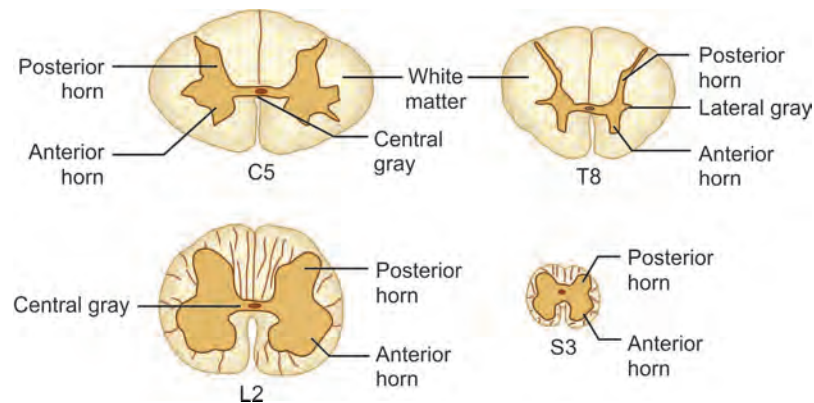


FIGURE 4 Structure of spinal cord. The sections show proportion of gray and white matter at different segmental levels

appear white in fresh specimens as they are myelinated. The gray matter lies internally and is made up of aggregation of cell bodies. The cells connected with a particular function, group together and are called nuclei. The glial cells constitute the connective tissue of the CNS. They are astrocytes and oligodendrocytes. They occupy both the gray and white matter.

To study the structure of the central nervous system in dissection hall Mulligan stain used. This stains thin CNS sections (See Appendix). This shows the gray matter deep purple and white matter white in color.

Dissection: Make 1 cm thin slices of spinal cord of midcervical, thoracic, lumbar and sacral levels. (Simultaneously observing the hematoxylin and eosin stained histological sections under dissection microscope at the same levels will be of great help in understanding the structure).

In freshly cut sections, the white matter appears dull white and the gray matter appears creamish in color.

Put the sections of different levels across and note the proportion of gray and white matter in these sections. Note that the white matter increases in quantity as we ascend up from coccygeal level to the cervical level. The fibres of the last coccygeal segment is the first one to enter the spinal cord. As we ascend up fibres of the other segments get added, by the time we reach the cervical level all the coccygeal, sacral, thoracic, and cervical level fibres get added, so the white matter is more in quantum in the cervical spinal cord when compared to the lower levels.

The gray matter size depends on the area of supply of that particular segment. The thoracic cord has the least amount of gray matter with thin H shaped area. It even shows a small lateral horn. This lodges preganglionic cell bodies of the sympathetic system motor pathway. The cervical and lumbar gray matter shows a wide anterior horn as it gives motor fibres to the upper and lower limb musculature.

SECTION OF THE SPINAL CORD—GRAY AND WHITE MATTER (Fig. 5)

CENTRAL CANAL: This occupies the center of the spinal cord. It is the persistent cavity of the neural tube.

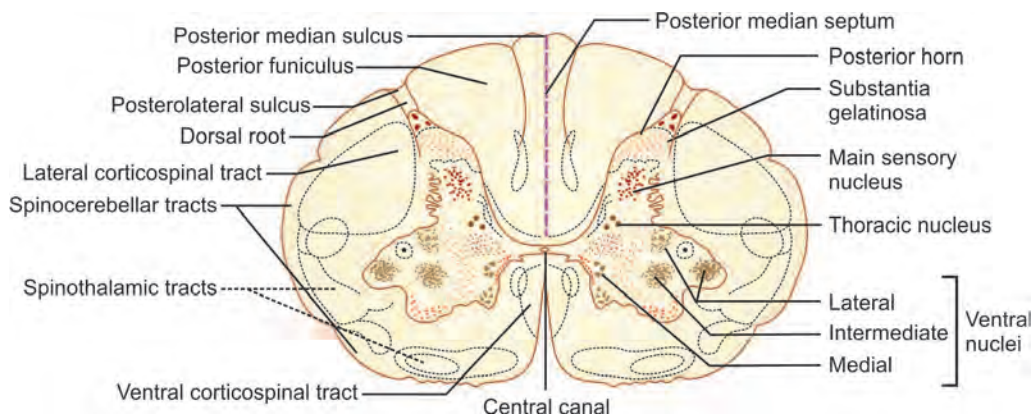


FIGURE 5 Section of spinal cord. This shows the nuclei and tracts

GRAY MATTER: Gray matter is made up of cell bodies and is located in the central part of the spinal cord in the form of columns but in sections it appears like horns, so they are named as posterior horn, lateral horn, anterior horn and central gray. It presents a H shaped appearance.

Posterior horn: The cell bodies of the posterior horn form the second order neurons in the sensory pathway. They receive the axons of the neurons in the dorsal root, synapse and send the second order neurons to the thalamus and cerebellum. The cell bodies accumulate into groups according to the function they are related with. **Substantia gelatinosa** receives pain and temperature fibres and send them to thalamus. **Main sensory nucleus** receives touch and pressure fibres and sends them to thalamus. **Thoracic nucleus** (C8-L3) receives proprioceptive fibres and sends them to cerebellum.

Lateral horn nuclei (T1 to L2) lodge the cell bodies of preganglionic neurons of motor pathway of the sympathetic nervous system. They receive corticospinal fibres and send to the smooth muscles of internal organs through the sympathetic chain.

Anterior horn: Cell bodies are second order neurons in the motor pathway. They receive the motor neurons through the pyramidal tract or corticospinal tract and send its axons to the skeletal muscles through the ventral nerve roots. They can be identified as three rows of nuclei. The **medial group** supplies the trunk musculature. The **intermediate group** supplies the diaphragm. The **lateral group** supplies the limb musculature. The ventral horn is accordingly variable in its size.

Central gray: It is the horizontal bar of gray matter on either side of the central canal. It has the cell bodies of the autonomic neurons.

WHITE MATTER: This lies peripheral to the gray matter. It is made up of both ascending and descending fibres. They are described as posterior funiculus and anterolateral funiculus (In gross sections the fibres cannot be identified. The diagram shows the position of the fibres).

Posterior median septum is a glial septum which extends from the posterior median sulcus to the posterior aspect of the central gray. **Posterior funiculus** lies between the posterior median septum and posterolateral sulcus. It has first order neurons in the proprioceptive sensory pathway. These fibres pass through the dorsal root enter the spinal cord segmentally, ascend up to relay in the medulla oblongata. **Septomarginal bundle** is a short intersegmental pathway

along the medial margin of the posterior funiculus. It is difficult to locate this in gross anatomical specimen.

Dorsal root: These fibres enter through the posterolateral sulcus. These are the axons of the cell bodies located in the dorsal root ganglion. Most of them relay in the posterior horn nuclei.

Anterolateral funiculus extends between the dorsal root and the anterior median fissure. It has both ascending and descending tracts. The ascending tracts occupy a more superficial position, whereas the descending fibres occupy a deeper position. ***Anterior and posterior spinocerebellar tracts*** are most superficial in position. They carry proprioceptive fibres from the thoracic nucleus to the cerebellum. ***Anterior and lateral spinothalamic tracts*** are second order neurons. They carry general sensations from the spinal cord to the thalamus. ***Tecto, reticulo, olivospinal tracts and spino olivary, reticular, tectal tracts*** form the tracts connecting reciprocally.

Observe the spinal cord sections at different levels. Study the arrangement, nature of crossing, function and the result of damage caused to all these tracts.

BRAIN

The brain lies within the cranial cavity, covered by meninges. For convenience of description it is divided into the following parts.

Medulla oblongata	}	Hindbrain
Pons		
Cerebellum		
Mid brain	}	Forebrain
Cerebral hemispheres		
Diencephalon		

Medulla oblongata, pons and midbrain are called brainstem. They are continuous with spinal cord and have a similar structure.

To study the brain it is convenient to have a full brain as well as a midsagittal section. The full brain can be used for dissection and the section is to be used for reference.



EXTERNAL FEATURES

MENINGES

When we take the stored brain out for study, it has the arachnoid and pia mater. The dura mater remains in the cranial cavity as it is firmly adherent to it.

Arachnoid mater (Fig. 6): It covers the brain on all aspects and is continuous with the spinal arachnoid mater at the foramen magnum. It crosses over all the depressions. It is thicker than pia mater, so it does not penetrate into the gaps between the parts of the brain. As a result big spaces are created between the arachnoid and pia., and these spaces are filled by CSF. These areas are called cisterns. Apart from the CSF the blood vessels lie between the arachnoid and pia.

Dissection: Peel the arachnoid mater from the ventral surface of the brain and observe the following—subarachnoid cisterns, attachment of cranial nerves and blood vessels (**Figs 6 and 7**).

SUBARACHNOID CISTERNS

Cerebellomedullary cistern/Cisterna magna: It is present laterally and posteriorly between the pons, medulla oblongata and the cerebellum. This communicates with the fourth ventricle through the foramen of Magendie in the midline and foraminae of Luschka laterally.

Cisterna pontis: This lies anterior to the pons and lodges the basilar artery and its branches.

Interpeduncular cistern: It is seen on the ventral aspect bounded by the pons inferiorly, the temporal lobes laterally and optic chiasma anteriorly. This lodges the circle of Willis and its branches.

Callosal cistern: It is seen in midsagittal section around the corpus callosum.



FIGURE 6 Arachnoid mater. Note that it is a thin sheet covering the blood vessels. Nerves and parts of the brain

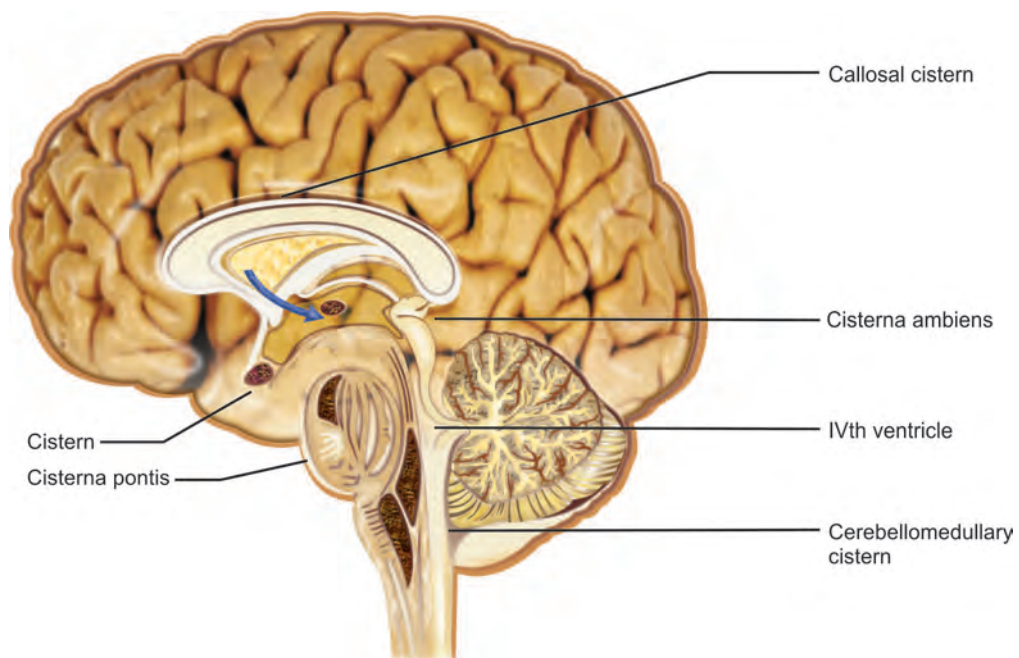


FIGURE 7 Midsagittal section showing subarachnoid cisterns

Cisterna ambiens: It is seen in the midsagittal section between the splenium of the corpus callosum and the superior colliculi. It lodges the great cerebral vein.

(Study the formation, composition and circulation of CSF)

STUDY OF BLOOD VESSELS (Fig. 8)

The blood vessels are located in the subarachnoid space. The arteries come from **vertebral artery and the internal carotid artery**. They anastomose on the ventral aspect of the brain and from there give off branches to supply the different parts of the brain. The veins accompany the arteries, lie superficially and drain into the neighboring venous sinuses. The venous sinuses were already studied while dissecting the dura mater.

Dissection: Identify the following arteries and trace their branches. Pull them out and see the fine vessels (end arteries) penetrating into the substance of brain.

VERTEBRAL ARTERIES: These arteries enter the cranial cavity through the foramen magnum along the lateral side. The right and left arteries join up together to form the basilar artery at the junction of pons and medulla oblongata.

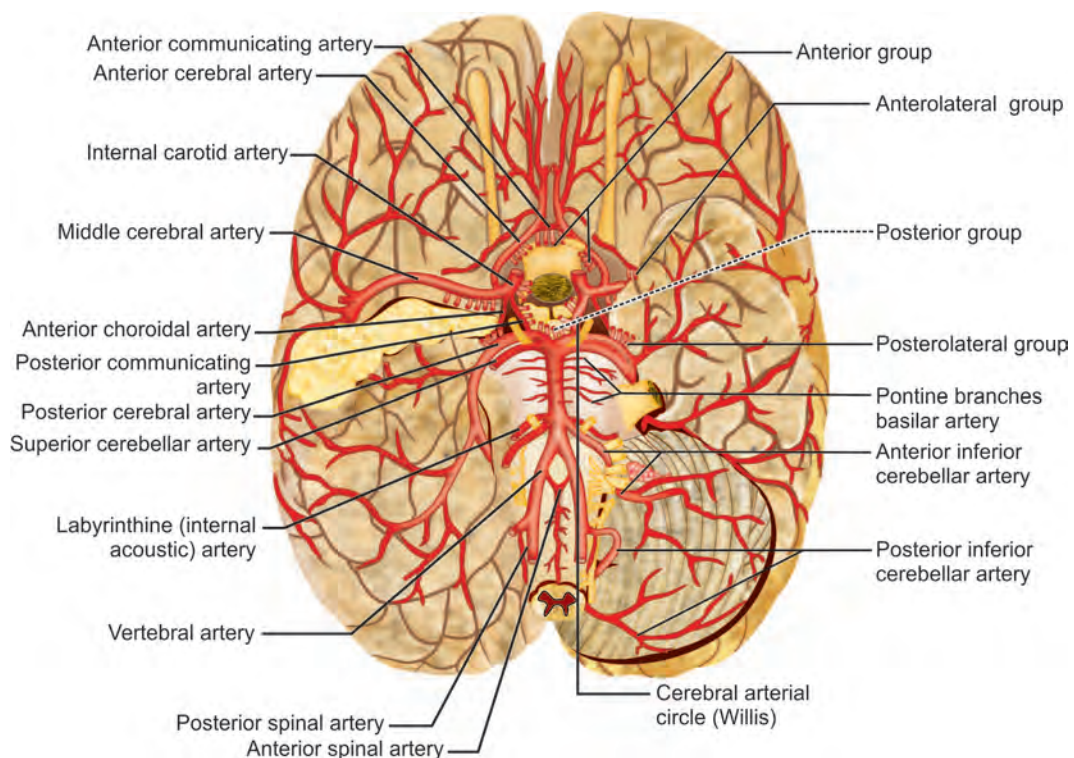


FIGURE 8 Base of the brain showing arachnoid cisterns and arteries

Branches: The **posterior spinal artery** is first branch given off from the lateral aspect. It runs down along the dorsal rootlets of the spinal nerves. It supplies the lateral aspect of the medulla oblongata and spinal cord. **Posterior inferior cerebellar artery** is given off while the vertebral artery lies along the lateral side of the medulla oblongata. Generally it gives off the posterior spinal artery, or may arise as a common trunk. It passes in a tortuous course between the rootlets of the glossopharyngeal, vagus and hypoglossal nerves, where it supplies the nerves and the part of the medulla oblongata. It reaches the junction of the medulla oblongata and cerebellum where it gives off the choroidal branch to the 4th ventricle. Further when it reaches the cerebellum it supplies the posterior part of the inferior aspect of the cerebellar hemispheres. *Trace this artery and its branches.* **Anterior spinal artery** are two small arteries one from each vertebral artery given near their termination. They join up together to form a single spinal artery which runs in the anterior median fissure. This artery supplies the anterior and medial aspect of the medulla oblongata.

BASILAR ARTERY: It lies in the midline in front of the pons. It causes a depression along the midline of ventral aspect of pons. It divides into two posterior cerebral arteries at the upper end of pons.

Branches: **Anterior inferior cerebellar artery** is the 1st branch from the basilar artery. It runs a tortuous course to supply the anterior part of the inferior aspect of the cerebellum. *Trace it to the cerebellum.* **Pontine branches** are many small branches, they penetrate the pons and supply it. *Pull the basilar artery and identify them.* **Labyrinthine artery** is a branch that runs horizontally beyond the pons. It accompanies vestibulocochlear and facial nerve into the internal auditory meatus to supply the internal ear in the petrous part of the temporal bone. **Superior cerebellar artery** is a big branch given off from the distal part of the basilar artery. This runs round the pons to reach the superior aspect of the cerebellum and supplies it. See its ramification on the superior aspect of the cerebellum.

CIRCLE OF WILLIS

It is an arterial circle seen in the interpeduncular fossa. Note its hexagonal shaped formation.

The two **posterior cerebral arteries** form the inferior boundary. These are the terminal divisions of the basilar artery. *Locate these.* The **internal carotid artery** has entered the cranial cavity through the carotid canal. (Identify it on the skull). It reaches the brain after passing through the cavernous sinus. *Identify its three branches.* The **posterior communicating artery** runs downward to anastomose with the posterior cerebral artery. This forms the lateral boundary. Locate this thin branch.

Middle cerebral artery is a branch of the internal carotid. *Locate this artery in the lateral sulcus.*

Anterior cerebral artery is the terminal division of the internal carotid artery. *Locate it as it runs forward and medially to reach the cerebral fissure,* between the two cerebral hemispheres. This forms the anteriomedial boundary.

Anterior communicating artery is a small branch connecting the two anterior cerebral arteries. It forms the anterior boundary. *Pull the two cerebral hemispheres separate and locate this artery.*

CENTRAL BRANCHES: Six sets of central branches arise from the circle of Willis and penetrate the brain substance to supply deep central nuclei. These are all end arteries.

Anterior group arises from the anterior cerebral artery and anterior communicating artery. *Pull the artery forward* and note their branches penetrating the anterior part of the lateral ventricle. This group supplies the caudate nucleus, putamen and anterior aspect of internal capsule. **Anterolateral group** arises from the middle cerebral artery and penetrate the area between the olfactory stria and

is called the anterior perforated substance. *Locate this area by gently pushing the optic chiasma medially. Pull the middle cerebral artery forwards and locate the small branches penetrating this area.* It supplies thalamus, deep nuclei and internal capsule. One of its bigger branches of great clinical importance is called arteries of cerebral hemorrhage, as this is the artery which often gets blocked. **Anterior choroidal artery** is another identifiable branch of the middle cerebral artery. This is given off as it passes through the lateral sulcus. *Pull the middle cerebral artery medially and locate this artery lateral to the posterior communicating artery.* It enters the choroidal fissure of the inferior horn of the lateral ventricle and forms the choroidal plexus. **Posterolateral group** arises from the posterior cerebral artery beyond the communication with the posterior communicating artery. *Locate it as it runs round the midbrain to supply the meta thalamus and internal capsule.* **Posterior group** arises from the posterior cerebral arteries near the midline. *Gently pull the posterior cerebral arteries towards you and locate the group of arteries entering into the brain substance in the midline to supply the hypothalamus.* This area is called the posterior perforated substance. **Posterior choroidal artery** is given off when posterior cerebral artery reaches the back near the splenium of the corpus callosum. Here it enters the choroidal fissure of the lateral and third ventricles and forms the choroids plexus. *Locate this artery in the sagittal section.*

CORTICAL BRANCHES: They arise from the anterior, middle and posterior cerebral arteries, the distribution can be studied at a later stage.

Dissection: Carefully remove the main arteries from the ventral aspect and identify the cranial nerves.

ATTACHMENT OF CRANIAL NERVES (Fig. 9)

Except for the trochlear nerve which is attached to the dorsal aspect, all the other eleven cranial nerves are attached to the ventral surface of the brain.

Olfactory nerve I: It has many rootlets. They pierce through the cribriform bone of the ethmoid and enter the olfactory bulb. It has got cell bodies of the second order neurons in the pathway of smell. *These nerves are too fine and they get cut while removing the brain.* They end in the olfactory bulb.

Optic nerve II: Note the thick flat nerves and the optic chiasma forming the anterior boundary of the interpeduncular fossa. It is a sensory nerve for vision.

Oculomotor nerve III: Locate this nerve between the posterior cerebral artery and the superior cerebellar artery on the medial side of the cerebral peduncles. This is a thick nerve which supplies the muscles of eyeball.

Trochlear nerve IV: Press the cerebellum gently forwards and locate this nerve below the inferior colliculi. *Trace it along the sides of the cerebral peduncles.* It supplies the superior oblique muscle.

Trigeminal nerve V: It is a thick nerve attached to the ventral aspect of the pons, between the pons and middle cerebellar peduncle. You can easily make out two roots at its attachment on pons—the smaller motor root – supplies the muscles of mastication. The bigger sensory root, carries sensations from the facial skin. This separates the pons from the middle cerebellar peduncle.

Abducent nerve VI: It is thin nerve between the pons and the pyramids of medulla oblongata. It supplies the lateral rectus of the eyeball.

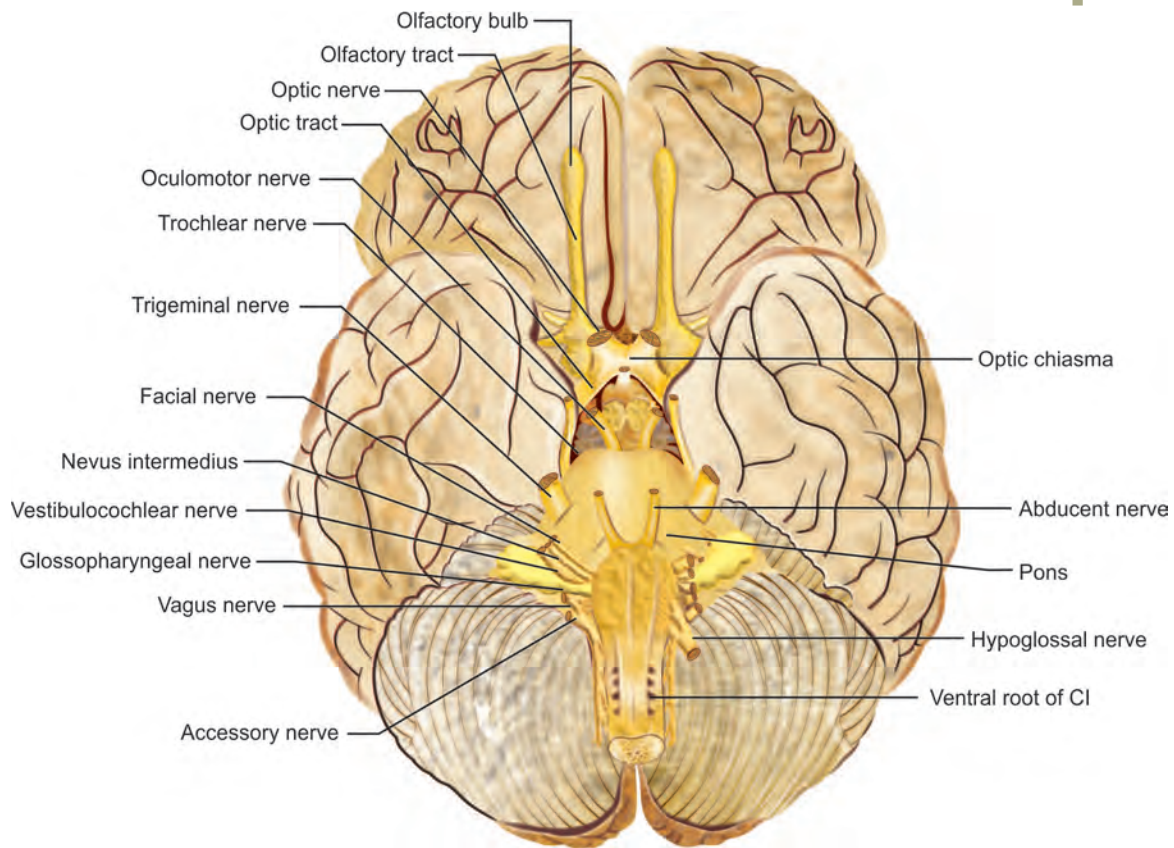


FIGURE 9 Attachment of cranial nerves

Facial nerve VII, nervus intermedius and vestibulocochlear nerve VIII: Locate these three thick nerves seen between the pons, medulla oblongata and the cerebellum. Facial nerve supplies muscles of facial expression, nervus intermedius carries taste sensations, vestibular nerve controls equilibrium and cochlear nerve carries auditory sensations.

Glossopharyngeal IX, vagus X and accessory XI nerves: These are attached along the posterolateral sulcus between the olive and inferior cerebellar peduncle, by number of rootlets. They supply the pharynx, larynx and GI tract. *Locate these rootlets.* They are mixed nerves. They have motor fibres to supply the muscles of branchiomeric origin and glands, carry taste and general sensations from the internal organs.

Hypoglossal nerve XII: This nerve leaves the medulla oblongata along the anterolateral sulcus between the pyramid and olive by number of rootlets. This nerve supplies the musculature of the tongue.

(Study the functional components of all these nerves)

STUDY OF MIDSAGITTAL SECTION (Fig. 10)

The prominent feature in the midsagittal section is the cavity of the brain. The central canal which is a narrow tube in the spinal cord expands in the brain to form ventricles.

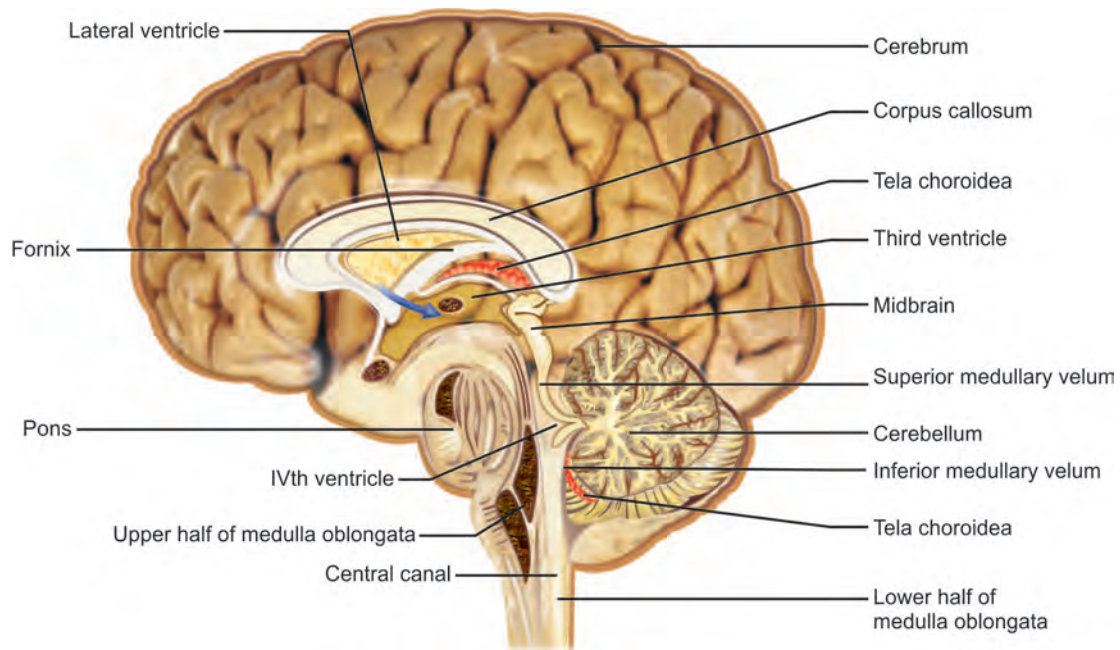


FIGURE 10 Midsagittal section

VENTRICLES: The **IV ventricle** is the cavity of the hindbrain. Note this cavity between pons and upper medulla anteriorly and cerebellum posteriorly. **Third ventricle** is the cavity of the thalamic complex. It is irregular in outline and is a single cavity in the midline. Note the cerebral aqueduct connecting the third and fourth ventricles. The cavity of the cerebrum is the **lateral ventricle**. They are two in number one in each cerebral hemisphere. Identify the septum pellucidum which separates the two lateral ventricles.

The brain substance around the ventricles is described as follows:

Lower half of medulla oblongata: Note that it is a tubular structure with the central canal more towards the posterior aspect.

Upper half of medulla oblongata: Anteriorly is more bulky, due to the accumulation of the nuclear matter. Posteriorly it is deficient. Here the central canal communicates into the cerebromedullary cistern.

Pons: This is the prominent anterior bulging part. It is clearly separated from the medulla oblongata below and the midbrain above.

Cerebellum: This occupies the area behind the upper part of the medulla oblongata and the pons. Identify the central recess forming the roof of the IVth ventricle.

Superior medullary velum: Note this thin sheet of white matter connecting the cerebellum to the midbrain in the midline. It is lined by the ependyma.

Inferior medullary velum: Note this thin white matter covered by the ependyma in the lower sloping surface of the cerebellum.

Tela choroidea: This is the blood vessels covered by the pia mater. Note this between the inferior medullary velum and the lower half of the cerebellum.

Midbrain: This part is located above the pons and cerebellum. It is relatively shorter anteriorly compared to the posterior part. The posterior part is formed by the colliculi. The cavity of the midbrain is the narrow cerebral aqueduct of Sylvius.

Thalamic complex: It is the part that lies around the third ventricle. It is made up of thalamus, hypothalamus, epithalamus and metathalamus.

Cerebrum: This is the most expanded part of the forebrain. In a sagittal section the commissural fibres which connect both sides get cut. The corpus callosum forms the prominent structure here. Identify this curved structure. Fornix is the other prominent commissure. *Note the septum pellucidum* connecting these two commissures. The part of the cerebrum seen on this surface is called the medial side.

BRAINSTEM

The brainstem is made up of medulla oblongata, pons and midbrain in that order from the spinal cord to the forebrain. It is related to the basiocciput and basisphenoid anteriorly. Architecturally, it is similar to the spinal cord. The gray matter of the brain is occupied by the cranial nerves and their connections. The extrapyramidal system which produces a coordinated muscular movement has number of nuclei located in the brainstem. The fibre tracts which connect the different parts of the CNS lie external and form the white matter of the brain.

MEDULLA OBLONGATA

It is very much similar to the spinal cord in arrangement of gray and white matter. The upper half of medulla oblongata opens up posteriorly to form the IVth ventricle. Identify the external features.

Anterior Aspect (Fig. 11)

Anterior median fissure: *Locate this in the midline.* This is a continuation of the anterior median fissure of the spinal cord. Not the crossing of the fibres in the lower part. The fissure is obliterated at the lower part of the medulla oblongata and the crossing of the fibres is called the **pyramidal decussation**. **Foramen cecum** is the upper expended end of the **anterior median fissure**. *Locate this* at the junction of the pons and medulla oblongata.

Pyramids: These are elevations on either side of the anterior median fissure. Note that pyramids are prominent structures in the upper part of medulla oblongata but narrow down in the lower part. They are constituted by the corticospinal tracts. As the name signifies they are the descending fibres beginning at the cerebral cortex and reach the spinal cord. Many of the pyramidal fibres cross and form lateral corticospinal tracts and the uncrossed fibres continue as the anterior corticospinal tract. The crossing of these fibres is the pyramidal decussation.

Anterolateral sulcus: This lies between the pyramids and olive. Identify the rootlets of the hypoglossal nerve in this sulcus. This sulcus is continuous with the anterolateral sulcus of the spinal

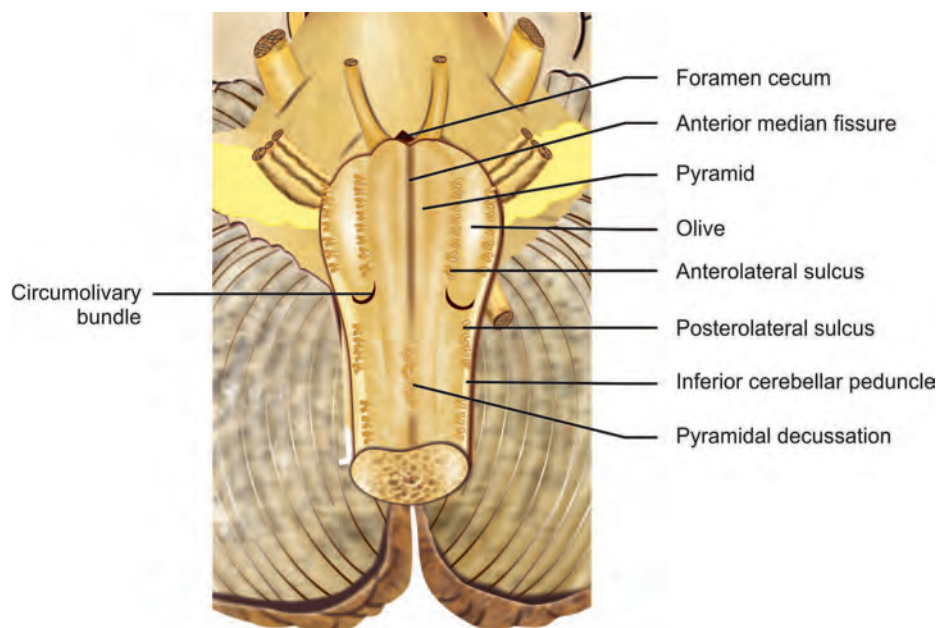


FIGURE 11 Medulla oblongata—Anterior aspect

cord through which the ventral, motor roots of the spinal cord emerge. The hypoglossal nerve supplies the musculature of the tongue.

Olive: It is the raised oval elevation caused by the deeply lying olivary nucleus. It is a part of the extrapyramidal system. It receives afferents from the cortex and spinal cord and sends efferents to the cerebellum.

Posterolateral sulcus: Locate this sulcus between olive and inferior cerebellar peduncle. See the rootlets of glossopharyngeal, vagus and accessory nerves in that order from above downwards. This sulcus is continuous inferiorly with the dorsilateral sulcus through which the dorsal rootlets of the spinal nerves enter.

Circumolivary bundle: Locate this semicircular bundle below the olive. This begins from the displaced arcuate nuclei located on the pyramids. The fibres wind round the olive to reach the cerebellum through the inferior cerebellar peduncle. These are displaced parts of corticocerebellar fibres.

Inferior cerebellar peduncle: Locate this stem like structure lateral to the olive. It reaches deep to the middle cerebellar peduncle (will be discussed with cerebellum).

POSTERIOR ASPECT (Fig. 12)

Dissection: Turn the part posteriorly, push the medulla oblongata forwards and identify the following (**Fig. 12**).

Posterior median sulcus: Locate this midline depression on the posterior aspect of the spinal cord and it opens up in the upper part of the medulla oblongata. It is continuous with the posterior median sulcus of the spinal cord. Note that this sulcus opens up in the upper part of medulla oblongata.

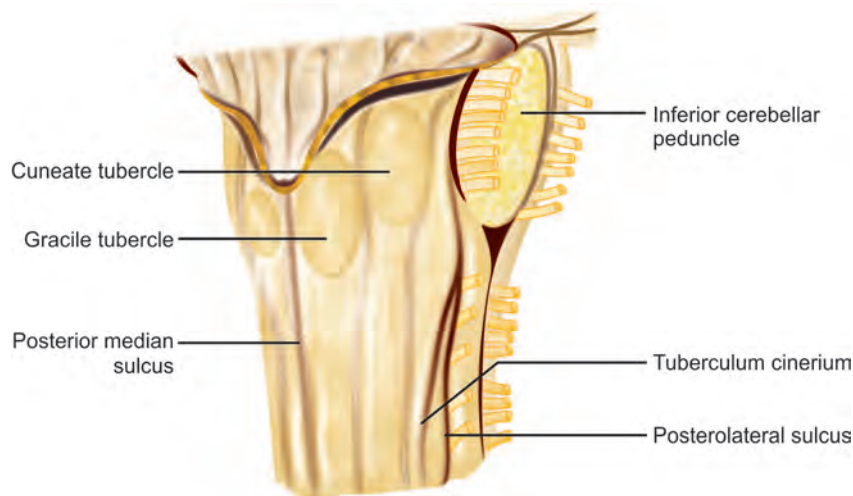


FIGURE 12 Medulla oblongata—posterior aspect

Gracile tubercle: This is the elevation lateral to the widening part of the posterior median sulcus. The gracile nucleus underlies this tubercle. This nucleus receives proprioceptive fibres of the lower half of the body.

Cuneate tubercle: Locate this tubercle lying superior lateral to the gracile tubercle. It is due to the underlying cuneate nucleus. This receives proprioceptive fibres of the upper half of the body.

The second order neurons from gracile and cuneate nuclei form the internal arcuate fibres and ascend up as the medial lemniscus.

Tuberculum cinereum: Identify this elevation between the cuneate fasciculus and the posterolateral sulcus. This is caused due to the underlying spinal tract of trigeminal nerve.

Inferior cerebellar peduncle: This is a big bundle lies between the cuneate tubercle olivary nucleus.

PONS (Fig. 13)

Pons is the expanded part of the brainstem. It has a ventral part which is visible in the anterior aspect. The posterior part forms the floor of IV ventricle and is totally overlapped by the cerebellum.

Note: The ventral depression caused due to the presence of the basilar artery.

On either side of the artery the pons shows bulges. This is due to the underlying pontine nuclei. The ventral part is called the basilar part of pons. The dorsal part is called tegmentum and has cranial nerve nuclei.

Trigeminal nerve V: The fibres of trigeminal nerve are attached to the pons at the junction of pons and middle cerebellar peduncle.

MIDBRAIN

Midbrain is the upper part of the brainstem. It is a tubular structure. The cavity of midbrain is called aqueduct of Sylvius. The part anterior to the aqueduct is called the cerebral peduncle, the part posterior is called the tectum. It is made up of two pairs of colliculi and is also called as corpora quadrigemina.

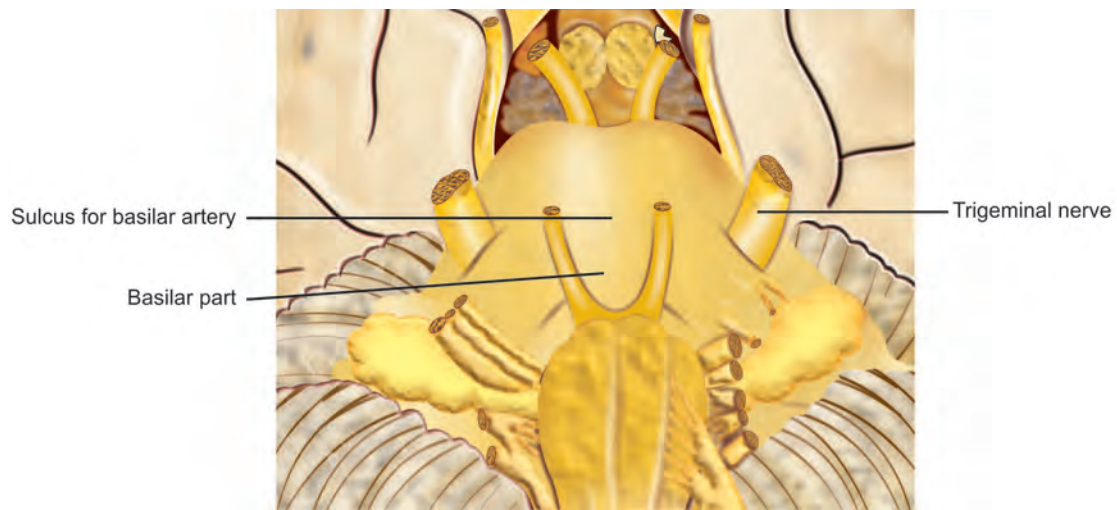


FIGURE 13 Pons—anterior aspect

ANTERIOR ASPECT (Fig. 14)

Crus cerebri: Identify this anterior most part of the cerebral peduncle. This is made up of the corticospinal and corticopontine fibres. These are the diverging fibre bundles extending from the upper border of the pons to the forebrain.

Hypothalamic structures: These parts of hypothalamus push themselves to lie between the crura. The *tuber cinereum* is an elevation in the midline. It is connected to the pituitary gland through infundibulum. *Mamillary bodies* are below the tuber cinereum and are one on either side of the midline. *Optic chiasma* and *optic tract* limit the anterior and anterolateral aspect.

Dissection: Turn the brain posteriorly, press the cerebellum downwards and identify the posterior aspect of midbrain.

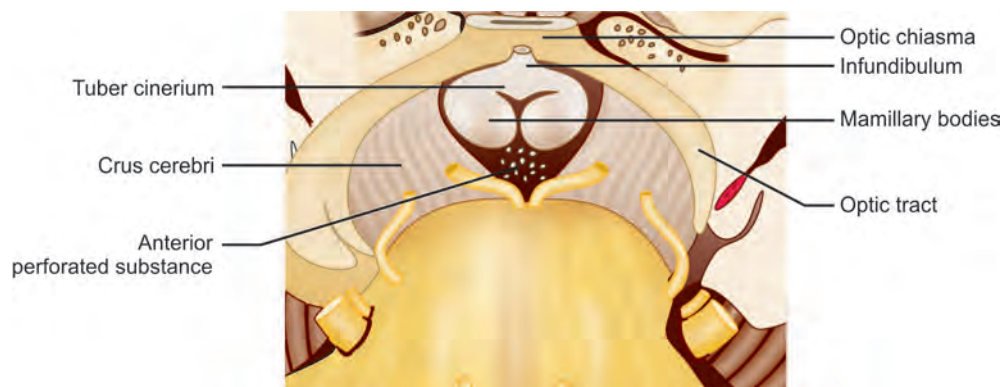


FIGURE 14 Midbrain—anterior aspect

POSTERIOR ASPECT (Fig. 15)

Tectum/corpora quadrigemina: The *superior Colliculi* are the upper bodies of the corpora. They are reflex centers in the visual pathway. The *inferior colliculi* are the lower bodies of the corpora. They are reflex centers in the auditory pathway. *Frenulum veli* separates the right side from the left side.

Trochlear nerve IV: This leaves below the inferior colliculi on either side of the midline. The nerve winds round the crus cerebri to reach the ventral aspect. It supplies the superior oblique muscle of the eyeball.

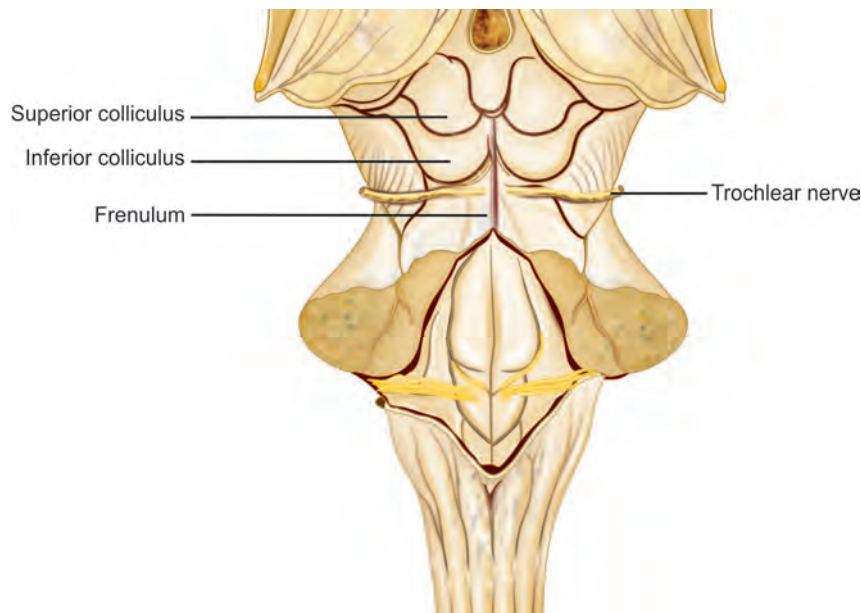


FIGURE 15 Midbrain—posterior aspect



CEREBELLUM

Dissection: Sever the brainstem from the forebrain. The cut should pass anteriorly near the upper part of the crus cerebri and posteriorly through the superior colliculus. Take the part in hand and study the surfaces of cerebellum.

The cerebellum is located posterior to the pons and medulla oblongata. It is an integrating center for the muscular coordination. It receives sensory impulses particularly the proprioceptive fibres from different parts of the body. It also receives the outgoing 1st order motor neurons from the cerebral cortex. It received so many array of fibres, the cerebellum has developed an outer gray matter to receive and integrate these fibres. The incoming and outgoing fibres constitute the white matter. Fibres arising from the gray matter form internuncial neurons and end on the cerebellar nuclei. The outgoing fibres of the cerebellum arise from these internal nuclei. So its structure is very much similar to the cerebral cortex with an outer folded gray matter and a inner white matter with a internally located nuclear matter.

The cerebellum presents a superior surface, inferior surface, an anterior notch and a posterior notch.

Superior surface (Fig. 16): It is separated from the cerebrum by the tentorium cerebelli. It looks uniform with raised central elevation called the superior vermis and on either side are the cerebellar hemispheres. The vermis and hemispheres are continuous with each other.

Inferior surface: This surface also presents a central vermis and two lateral cerebellar hemispheres. The central vermis is separated from the hemispheres by the vallecular depression. Pull the cerebellum slightly and identify the inferior surface.

Fissura prima: *Identify this fissure.* This separates the anterior lobe from the posterior lobe.

Horizontal fissure: This separates the superior and inferior surface of the cerebellum. *Locate this* at the junction of the cerebellum with the pons where the superior and inferior surface come closer. Trace it round the cerebellum to the posterior aspect of it.

Dissection: Reidentify the cerebellomedullary cistern between the medulla oblongata and the inferior surface of cerebellum. Slightly pull the medulla oblongata forwards and note the pia mater extending between the two. The prominent foramen of Magendie is easily identifiable in the center. Trace the pia mater laterally to the junction between the cerebellum, pons and medulla oblongata, and identify the lateral foramen of Luschka. Note the projecting choroids plexus in both these openings.

Choroid plexus: It is the capillary plexus in the roof of the 4th ventricle. A branch of the posterior inferior cerebellar artery contributes to its formation. It enters between the two layers of the pia mater. It is shaped like a T when arteries of both sides meet. The blood vessels form a capillary plexus. It pushes the pia and the ependyma and is seen as a grape like structure and CSF is formed thereby filtration.

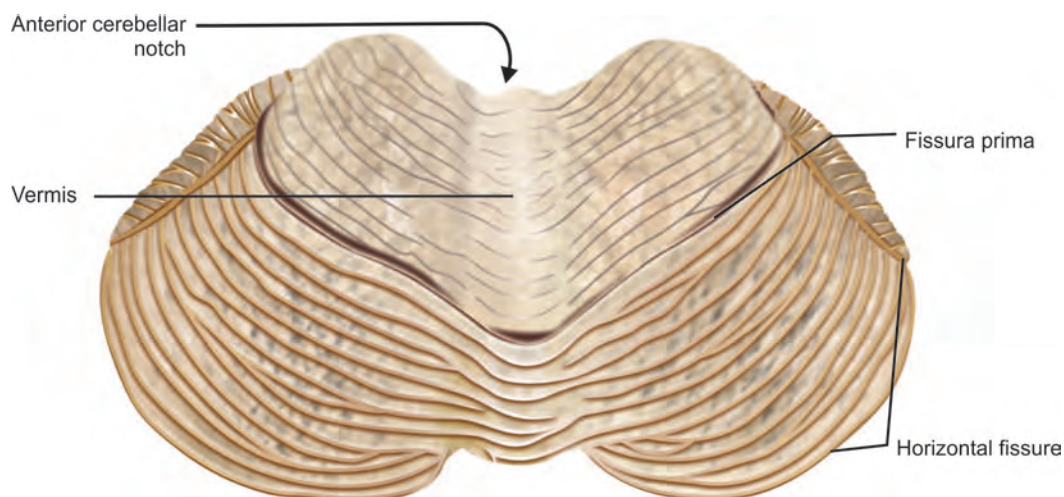


FIGURE 16 Cerebellum—superior aspect

ANTERIOR CEREBELLAR NOTCH (Fig. 17)

Dissection: Cut the cerebellum from the hindbrain near the peduncles. Take the cerebellum in hand and study its features.

Look at the anterior aspect of the cut part of the cerebellum. Right in the midline a tent like depression is seen. This is the roof of the fourth ventricle in the center of the vermis, it is called **superior recess**. Put a blunt edge of the scalpel and see its depth. It slopes superiorly to form superior medullary velum and inferiorly to form inferior medullary velum. All these parts are lined by the ependyma.

Superior medullary velum: This is a thin sheet of white matter covered by pia mater. It ascends up to the midbrain between the two superior cerebellar peduncles.

Inferior medullary velum: Look at the inferior surface and note the thin inferior medullary velum in the midline. It forms the roof of the inferior half of the 4th ventricle. The choroid plexus of the fourth ventricle is located here.

Choroid plexus and tela choroidea: Choroid plexus is the capillary plexus located in the ventricles. The capillary plexus is covered by the pia mater and it is called tela choroidea. In the IV ventricle it is T shaped.

The cerebellum is connected to the brainstem by three cerebellar peduncles. The superior cerebellar peduncle connects it to the midbrain. The middle cerebellar peduncle connects it to the pons and the inferior cerebellar peduncles connect it to the medulla oblongata. Locate their position on the cerebellum.

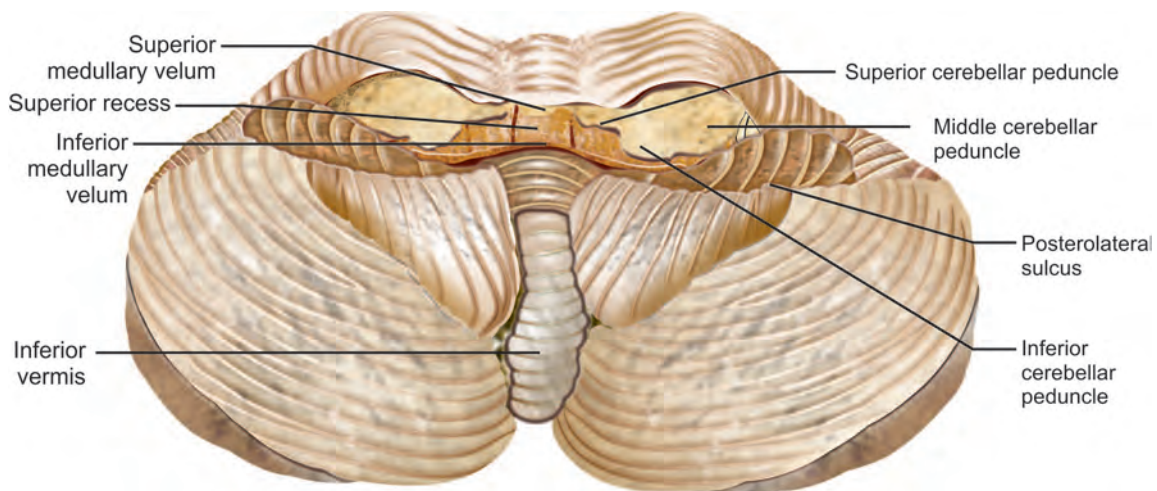


FIGURE 17 Cerebellum—inferior aspect

VERMIS (Fig. 18)

Dissection: Cut the cerebellum in the midline and divide it into two halves.

Observe the cut parts. The vermis presents a central white core covered by gray matter. The appearance of gray and white matter looks like branches of a tree. So the arrangement is called arbor vitae arrangement.

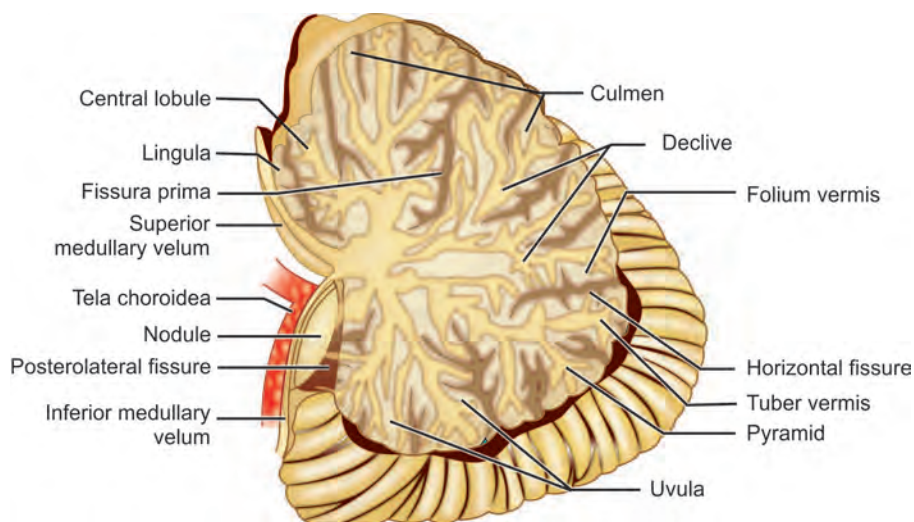


FIGURE 18 Cerebellum—vermis

Note that the central vermal parts extend laterally into the cerebellar hemispheres. Deep fissures separate the parts of vermis. Lot of work was done on cerebellum and is classified based on different factors.

Following is the most accepted old classification.

Cerebellum is divided into **anterior, middle and posterior lobes**. Each lobe has a central vermal and a lateral hemisphere part. *Identify the following parts and the prominent fissures to identify the lobes.*

Identify **lingula** small part sticking to the superior medullary velum. **Culmen and declive**—identify these big vermal parts and the **fissure prima**. The fissure separates the anterior lobe from the middle lobe. The lingual culmen declive with the lateral extensions form the **anterior lobe**. **Folium vermis**—is a thin single folium below the declive. The fissure below it is the **horizontal fissure**. This separates the superior side from the inferior side. Trace it laterally. **Tuber vermis, pyramid, uvula**—are shaped like a bulge, pyramid and a tongue. Identify them in that order. See their lateral extensions. The lateral extension of the uvula is the **tonsil**. It is a prominent part and identify this. Identify the **posterolateral fissure**. This fissure lies between the nodule and uvula. It separates the middle lobe from the posterior lobe. **Nodule** is the small most anterior part of the inferior vermis. **Flocculus and paraflocculus** are the parts of cerebellar hemisphere extensions from the nodule. They can be easily identified projecting into the lateral recess of the fourth ventricle, the **foramen of Lushka**. Remove the tonsil to get a better view of the connection between the flocculus and paraflocculus.

Practice the names of all these parts of vermis and cerebellar hemisphere.

DEEP CEREBELLAR NUCLEI (Fig. 19)

Dissection: Make a horizontal cut through the middle of the cerebellum. Note the gray matter within the white matter of the cerebellum.

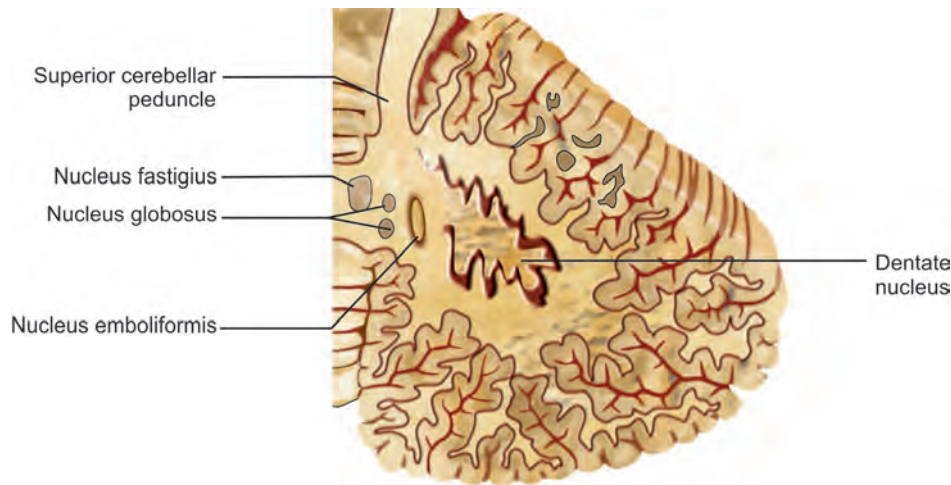


FIGURE 19 Deep cerebellar nuclei

Dentate nucleus: Identify this crenated nucleus occupying the major part of the white matter. The mouth of this nucleus faces towards the midline. It receives internuncial neurons from the gray matter. It sends efferent fibres through the superior cerebellar peduncle. They are the dentatorubral and dentatothalamic fibres. **Nucleus globose, emboliformis and fastigii**—these are smaller nuclear matter between the dentate nucleus and the midline. The nucleus fastigial shows reciprocal vestibular connections. Nucleus globosus and emboliform have reciprocal spinal connections.

PEDUNCLES OF CEREBELLUM (Fig. 20)

The cerebellum is connected to the brainstem through cerebellar peduncles. *Identify them on the brainstem now.* They all can be seen on the posterior aspect.

Superior cerebellar peduncle: It forms the upper part of the roof of the IV ventricle. It is seen on the posterior aspect of the brainstem. It is a thick fibre bundle connecting the cerebellum to the midbrain. You can see it as a prominent bundle extending from the cerebellum to the undersurface of the superior colliculus. It is predominantly made up of efferent or outgoing fibres of cerebellum. These start in the deep nuclei of cerebellum and reach the red nucleus and thalamus. It has only one descending tract—the anterior spinocerebellar tract.

Lateral lemniscus: Identify this bundle lateral to the superior cerebellar peduncle. These are the second order neurons in the auditory pathway. They begin in the auditory nuclei located at the junction of the pons and medulla oblongata. (Though it is not a cerebellar connection, it is shown here due to visibility of this structure here).

Middle cerebellar peduncle: It is seen as a thick lateral bundle of fibres. It connects the cerebellum to the pons. It is made up of corticocerebellar fibres. The corticocerebellar fibres relay in the pontine nuclei and the second order neurons cross to the opposite side and reach the cerebellum as the inferior cerebellar fibres. It is located on the lateral side of the brainstem.

Inferior cerebellar peduncle: *Locate this bundle between the superior and middle cerebellar peduncles.* It connects the cerebellum to the medulla oblongata. It has both afferent and efferent fibres. The afferents to the cerebellum come from the olivary nuclear complex through different tracts. Olivary nucleus is a part of extrapyramidal system. It modifies the motor functions initiated

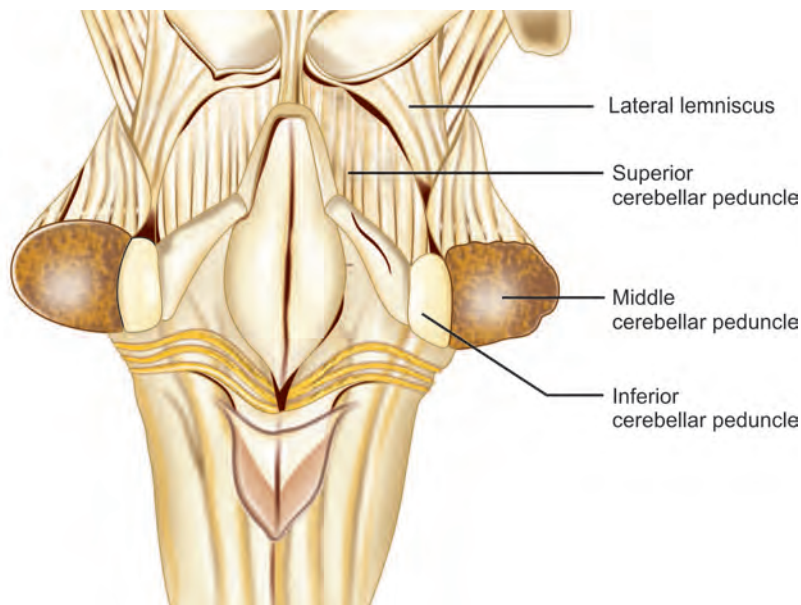


FIGURE 20 Cerebellum—peduncles

by the cerebral cortex. It also receives proprioceptive fibres from the lower part of the body through spinocerebellar fibres. The vestibular fibres come from vestibular nuclei. It also has efferent fibres to vestibular nuclei and spinal cord. It is on the posterolateral side of medulla oblongata.

Study the tracts in each peduncle from a Textbook.



FOURTH VENTRICLE (Fig. 21)

Fourth ventricle is the cavity of the hindbrain. It is a diamond shaped space. The floor of 4th ventricle is formed by the posterior aspect of the pons and upper half of medulla oblongata. The roof is formed by the cerebellum, and the superior and inferior medullary vela. It is tent like structure. The roof and floor meet at the curved lateral margin of the medulla oblongata except at the foramen of Magendie and foraminae of Luschka. Superiorly the 4th ventricle narrows up to form the aqueduct of the midbrain. Inferiorly it is continuous with the central canal.

Dissection: Note the following features on the posterior aspect of the brainstem.

Inferolateral border: It is formed by the obex, gracile tubercle, cuneate tubercle and the inferior cerebellar peduncle. The inferior medullary velum is attached along this margin.

Relocate the position of foramen of Magendie and the foramen of Luschka.

Median sulcus: It is the midline separation seen in the floor dividing it into right and left halves.

Medial eminence: See this elevation on either side of the sulcus in the pontine part of the fourth ventricle. This is caused by the underlying motor cranial nerve, the abducent nerve nucleus. The facial nerve fibres wind round the abducent nerve nucleus, so it is called **facial colliculus**.

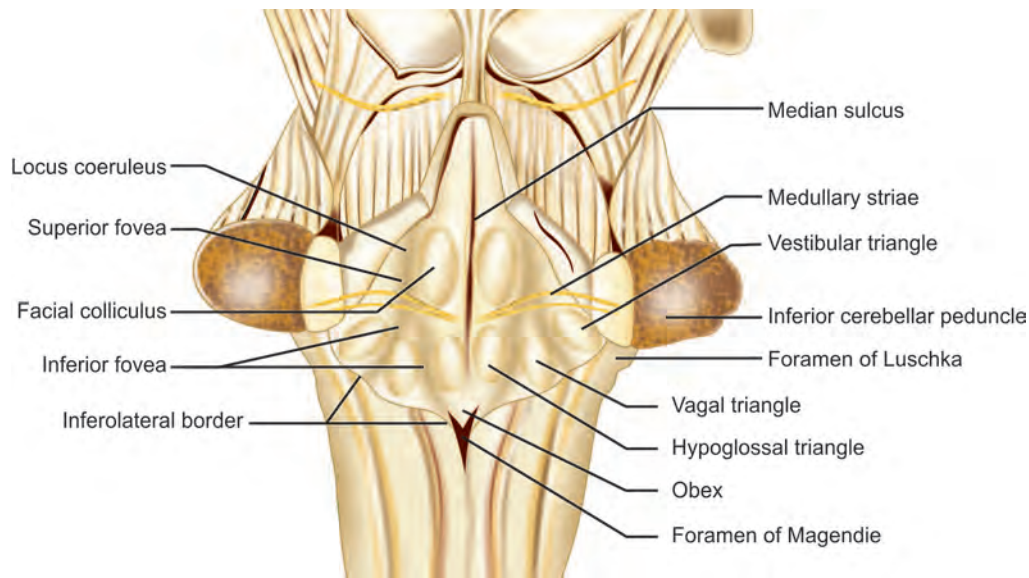


FIGURE 21 Fourth ventricle

Superior fovea: Note this depression lateral to the facial colliculus. The *locus coeruleus* is dark area just above the superior fovea. This is due to the pigmented cells present here.

Medullary striae: Note these horizontally running fibres at the junction of the medulla oblongata and pons. These fibres arise from the displaced pontine nuclei called arcuate nuclei. They begin on the anterior aspect of the pyramids sweep backwards through the center to reach the floor of the 4th ventricle. From the center of the median sulcus they run horizontally to reach the cerebellum.

Inferior fovea: Note this inverted Y-shaped depression which separates the medullary part of the medial eminence into three triangular elevations.

The hypoglossal triangle: Note this next to the median sulcus. It is caused by the hypoglossal nerve nucleus.

The vagal triangle: It is the elevation between the two limbs of the inferior fovea, caused by the vagal nerve nucleus. Funiculus separans is a thin fibrous elevation. It separates the vagal triangle from the area postrema which lies below the funiculus separans.

Vestibular triangle: Lateral to the inferior fovea and is caused by the vestibular nerve nuclei.

Obex: This is the point where the two gracile tubercles meet.



SECTIONS OF BRAINSTEM

Dissection: Make serial sections at the following levels, stain with Mulligan stain and try to identify the nuclear matter. The brainstem lodges the ascending fibres, descending fibres, cranial nerve nuclei and nuclei connected with extrapyramidal system.

SECTION THROUGH THE PYRAMIDAL DECUSSATION (Fig. 22)

The prominent feature at this level is the formation of the **pyramidal decussation**. Note this in the midline. Note that the anterior fissure is obliterated by the crossing pyramidal fibres. These are the **descending corticospinal fibres** or 1st order neurons in the motor pathway. Ninety percent of these fibres cross at this level. These fibres cross to the opposite lateral funiculus and form the **lateral corticospinal tract**. These crossing fibres separate the anterior horn from the central gray. Below the pyramidal decussation the pyramid is very much diminished in size. It carries only 10% of the remaining corticospinal fibres and is called anterior corticospinal tract.

Gray matter: It has the same features as the spinal cord. The anterior horn has the nucleus of the **spinal accessory nerve**. The substantia gelatinosa of the spinal cord is replaced by the **nucleus of the spinal tract of trigeminal nerve**. This nucleus receives the pain and temperature fibres of the face. The gracile and cuneate nuclei make their appearance in the respective fasciculi.

White matter: Note the **gracile and cuneate fasciculi** in the posterior funiculus. These carry proprioceptive fibres. Note the anterolateral funiculus. It is occupied by the **anterior and posterior spinocerebellar tracts**. These are the second order neurons in the proprioceptive pathway to the cerebellum. They occupy the area nearer to the surface. **The anterior and lateral spinothalamic tracts** lie deep to the spinocerebellar tracts. They are crossed second order sensory fibres to the thalamus.

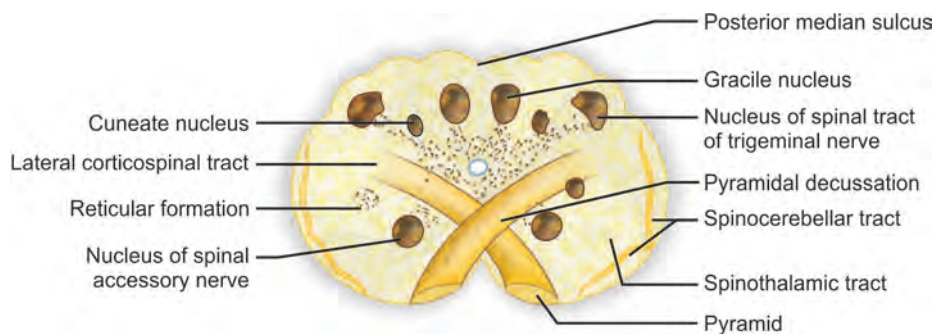


FIGURE 22: Section through the pyramidal decussation

SECTION OF SENSORY DECUSSATION (Fig. 23)

The prominent feature at the level is the formation of **gracile and cuneate nuclei** and the sensory decussation. Note these sweeping fibres from the gracile and cuneate nuclei in the posterior funiculus to the anterior funiculus round the central gray. The second order neurons beginning from here sweep the central gray, reach the area behind the pyramidal decussation. The sweeping fibres are called the **internal arcuate fibres**. The fibres from here ascend up as the **medial lemniscus fibres**. They carry second order neurons in the proprioceptive pathway to the thalamus.

Gray matter: The dorsal horn is represented by the **spinal tract of trigeminal** nerve and it lies laterally in the position of substantia gelatinosa. **Nucleus of tractus solitarius** lies in the central gray. The nucleus of tractus solitarius occupies a dorsal position. It is a relay center for the taste sensations. The second order neurons from here ascend up to the thalamus. **Vagus nerve nucleus** lies lateral in position. It is occupied by the dorsal nucleus of vagus. It has both motor and sensory components

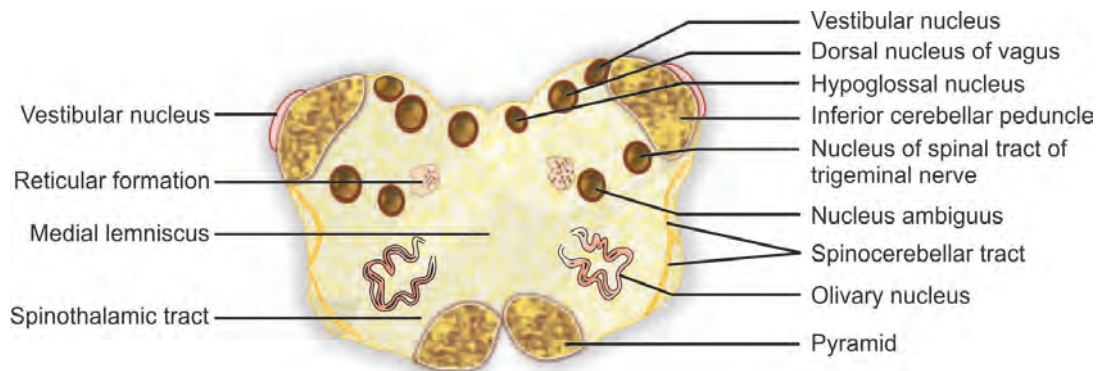


FIGURE 23: Section of sensory decussation

of autonomic nervous system. **Hypoglossal nerve nucleus** lies in the ventral gray near the midline. It is occupied by the hypoglossal nerve nucleus. It is motor to the muscles of tongue. **Nucleus ambiguus** is located in the position of the ventral horn. It is motor to the muscles derived from the branchial arches. **Reticular formation** is the fine dispersed nuclei present in the white matter present throughout the spinal cord and the brainstem.

White matter: This shows prominent pyramids lateral to the midline. The spinocerebellar and spinothalamic tracts and tracts belonging to the extrapyramidal system, all remain in their respective positions. Medial lemniscus is the newer bundle added between the central gray and pyramids. They are second order neurons in the proprioceptive pathway.

SECTION THROUGH THE OLIVARY NUCLEUS (Fig. 24)

The presence of the **olivary nucleus** lateral to the pyramid is the prominent feature in this section. Olivary nucleus is relay station in the cerebellar pathway. It receives fibres from the cortex and spinal cord and projects it to the cerebellum. It is a prominent indented nucleus at this level.

The central canal opens up to form the 4th ventricle.

The **hypoglossal, vagal and vestibular nuclei** lie in their respective triangles. Identify them based upon the triangles. **Nucleus of tractus solitarius** (pain sensations from face), **nucleus ambiguus** (branchial motor), **nucleus of spinal tract of trigeminal nerve** lie deep in the gray. The **vestibular nerve nuclei** lie on either side of the inferior cerebellar nuclei.

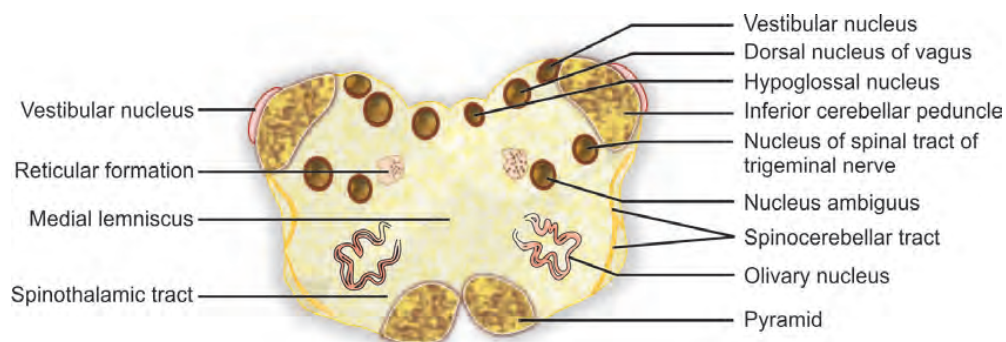


FIGURE 24: Section through the olivary nucleus

White matter: The *pyramids* anteriorly and *inferior cerebellar peduncle* laterally are the prominent features of the white matter. The *spinocerebellar tracts* occupy the peripheral position. The *spinothalamic tract* lies in front of the olivary nucleus. The *medial lemniscus* occupies the area dorsal to the pyramid. The fibres from the *extrapyramidal system* occupy the area between the medial longitudinal bundle and the central gray.

PONS THROUGH THE FACIAL COLLICULUS (Fig. 25)

Here pons forms the floor of the 4th ventricle. Pons exhibits dorsal tegmentum and ventral basilar part.

Tegmentum: This shows the cranial nerve nuclei in the central gray. The parts which are continuous with the medulla oblongata and midbrain occupy the area peripheral to the central gray. **Abducent nerve nucleus** lies deep to facial colliculus. *See the facial colliculus and identify the abducent nerve nucleus.* Note the fibres of the abducent nerve nucleus sweeping through the tegmentum. **Facial nerve nucleus** lies deep in the tegmentum. **Nucleus of spinal tract of trigeminal nerve** and **vestibulocochlear nerve nuclei** lie laterally.

Medial lemniscus, spinal lemniscus take a horizontal position inner to the basilar part.

Basilar part of pons: Basilar part of the pons has both cell bodies and fibres. The **pontine nuclei** are mixed with the fibres. The basilar part is dominated by the **corticoponti nuclear fibres**. These fibres come from cerebral cortex relay in pontine nuclei and reach cerebellum through middle cerebellar peduncle. Identify these horizontally running fibres. Note the transversely cut vertically running corticospinal fibres. Fine pontine nuclei are seen within the basilar part.

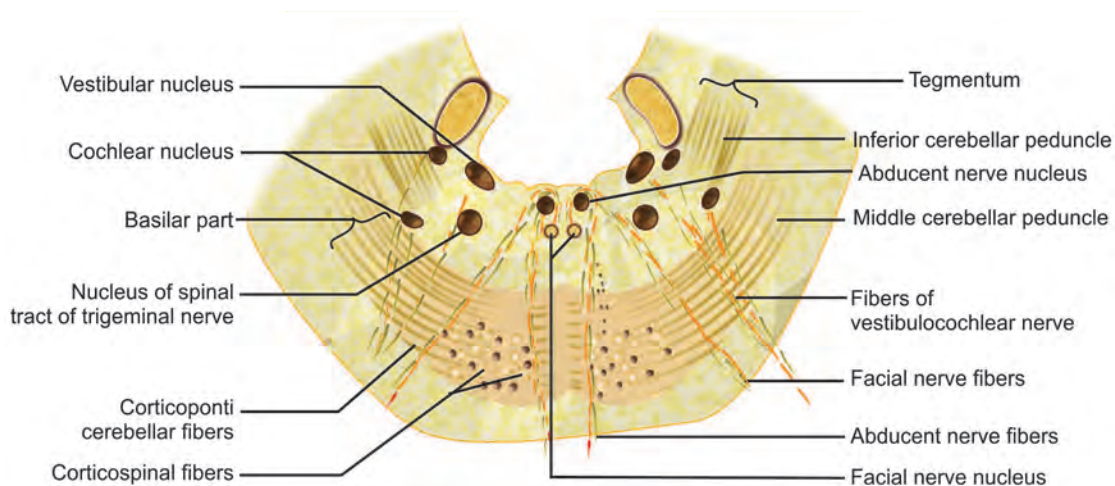


FIGURE 25: Pons through facial colliculus

PONS THROUGH TRIGEMINAL NERVE (Fig. 26)

Pons when cut carefully shows the enlarged cavity of the 4th ventricle with the roof formed by the superior medullary velum. Superolaterally look for the superior cerebellar peduncle.

Tegmentum

The **trigeminal nerve nuclei**: They form the major part here in the gray matter. This lies laterally, inner to the middle cerebellar peduncle. Locate the attachment of the trigeminal nerve on the pons.

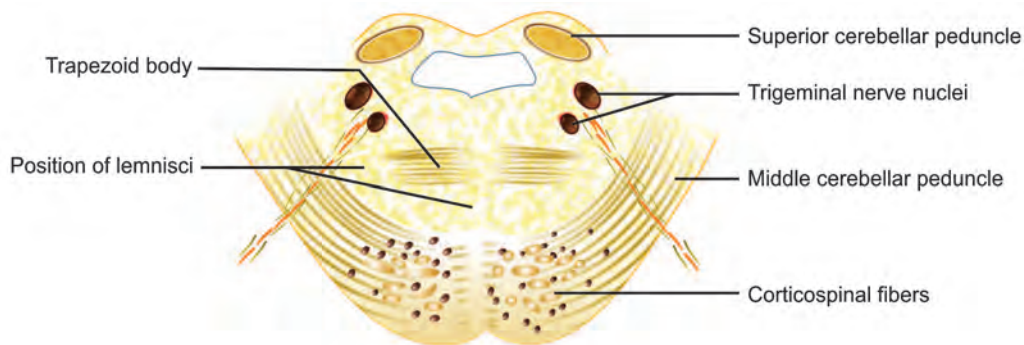


FIGURE 26: Pons through trigeminal nerve

Trace the trigeminal nerve nucleus inner to this. Note the **middle cerebellar peduncle** forming and lateral aspect in this section. **Trapezoid body** is the horizontally running second order neurons in the auditory sensory pathway. They begin in auditory nuclei and ascend up as lateral lemniscus. This lies between the tegmentum and the basilar part of pons. The **medial lemniscus** from gracile and cuneate nuclei, the **trigeminal lemniscus** from the trigeminal nerve nucleus, the **spinal lemniscus** from the nuclei of spinal cord in the posterior horn, occupy the space between the trapezoid body and the basilar part of pons.

Basilar part of pons: This shows the horizontally running **corticopontine nuclear fibres**, vertically running corticopontine fibres and pontine nuclei. Identify them fibres to cerebellum.

MIDBRAIN AT INFERIOR COLLICULUS (Fig. 27)

The midbrain is divided into two parts—tectum posterior to the central canal and cerebral peduncles in front of the central canal.

Tectum: At this level the tectum is formed by the nuclear matter of **inferior colliculus**. Note this nucleus. It is a reflex center in the auditory pathway. The fibres of the lateral lemniscus enters here.

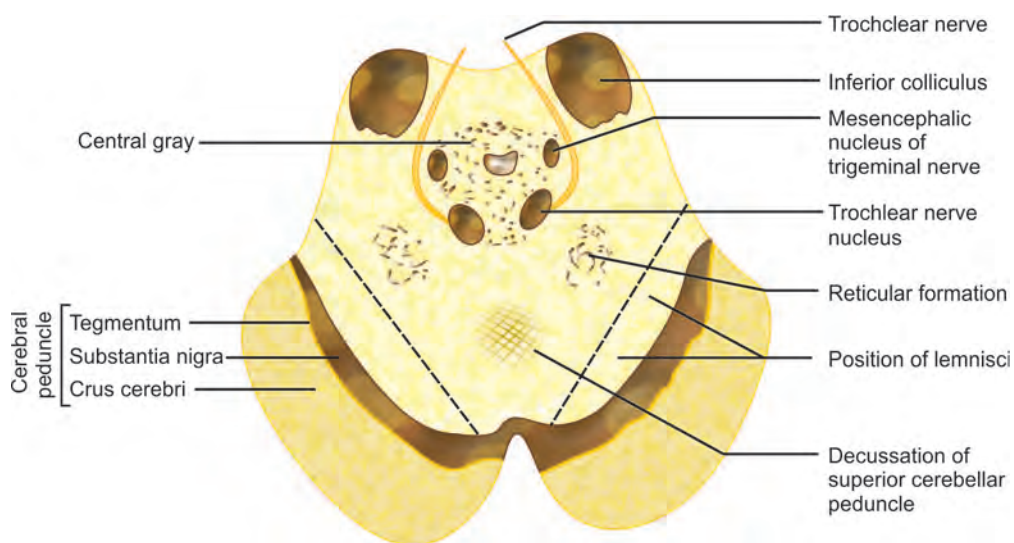


FIGURE 27: Midbrain at inferior colliculus

Cerebral peduncle is made up of three parts—tegmentum, substantia nigra and crus cerebri.

Tegmentum: The central gray shows the *mesencephalic nucleus of trigeminal nerve and trochlear nerve nucleus*. The trochlear nerve nucleus occupies a position lateral to the midline whereas the mesencephalic nucleus occupies a lateral position. Decussation of *superior cerebellar peduncle* in the midline ventral to central gray. These are the fibres from the deep cerebellar nuclei to the thalamus. They decussate before they reach the cerebrum. **Lemnisci**—lateral, spinal, trigeminal and medial—in that order from inferior colliculus to the cerebellar decussation. Though actual separation of these fibres cannot be identified in these sections, their position can be identified.

Substantia nigra: It is the nuclear matter with melanin pigment in their cells. So the area appears black in color. It lies between tegmentum and crus cerebri. It is a part of the extrapyramidal system.

Crus cerebri: It is made of descending white fibres both corticospinal, corticonuclear and corticopontine fibres.

Midbrain at Superior Collicular Level (Fig. 28)

Tectum: It shows superior colliculus. It is a nuclear matter. Note the thin white matter around it. This is due to the fibres entering into the nucleus. The superior colliculus is a reflex center for visual sensations.

Central gray: This shows *oculomotor nerve nucleus* on either side of the midline in the ventral gray. The *mesencephalic nucleus of trigeminal nerve* lies dorsal to the oculomotor nerve nucleus.

Cerebral Peduncle

Tegmentum: This shows red nucleus. This is a nuclear matter of extrapyramidal system. This is a very prominent feature at this level. The **lemnisci** show spinal, trigeminal and medial in that order from lateral to medial side, as lateral lemniscus has already entered into the inferior colliculus. Ventral tegmental decussation in the midline is caused by the rubrospinal fibres.

The substantia nigra: Note this pigmented gray matter. It is a part of the extrapyramidal system. **Crus cerebri** shows the same descending fibres.

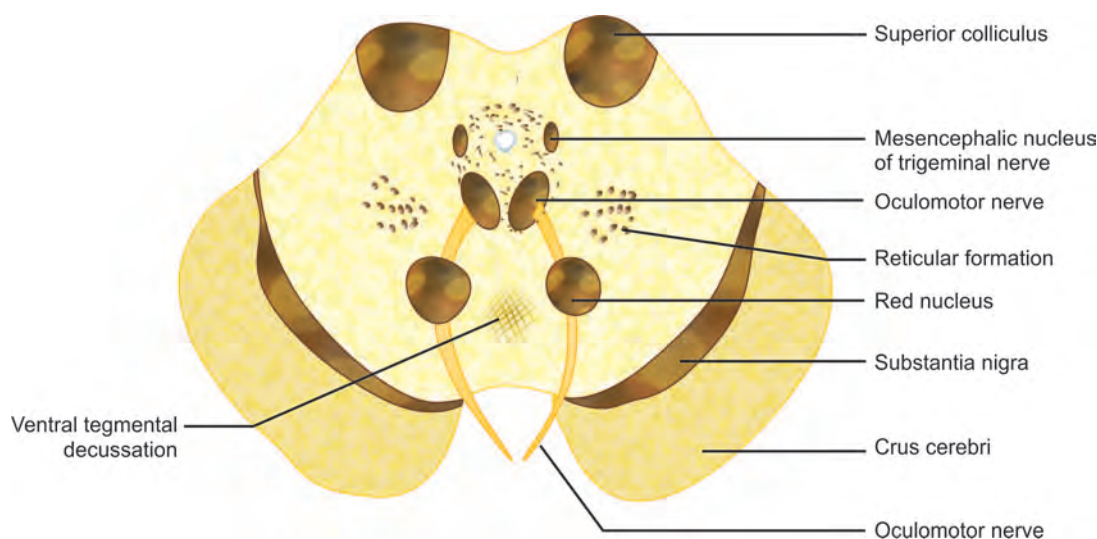


FIGURE 28: Midbrain at superior colliculus



FOREBRAIN

The forebrain is made up of cerebrum and thalamic complex. The cerebrum is the well developed part of the human development. It has got outer gray matter, inner white matter and basal ganglia within the white matter. The cavity of the forebrain is the lateral ventricle. The thalamic complex is made up of thalamus, metathalamus, epithalamus, hypothalamus and subthalamus. The cavity of the thalamic complex is the third ventricle. The cerebrum and thalamic complex merge with each other and it is convenient to study them together.

The cerebrum lodges the highest sensory and motor centers of the body. Multitude of the fibres inter connect these centers with different parts of the CNS.

BLOOD SUPPLY OF FOREBRAIN

Lateral Surface (Fig. 29)

Dissection: Carefully remove the arachnoid matter from the sulci on the superolateral surface of the brain and identify the veins draining this region.

Superior cerebral veins: These are number of longitudinally running channels opening into the superior sagittal sinus.

Superficial middle cerebral vein: This drains into the cavernous sinus.

Inferior cerebral veins: These drain the temporal lobe and drain into the transverse sinus.

Superior anastomotic vein: This connects the superior sagittal sinus to the superficial middle cerebral vein. This is a slightly enlarged vein of the superior cerebral veins.

Inferior anastomotic vein: This connects middle cerebral vein to the transverse sinus. This is a slightly enlarged vein of the inferior cerebral veins.

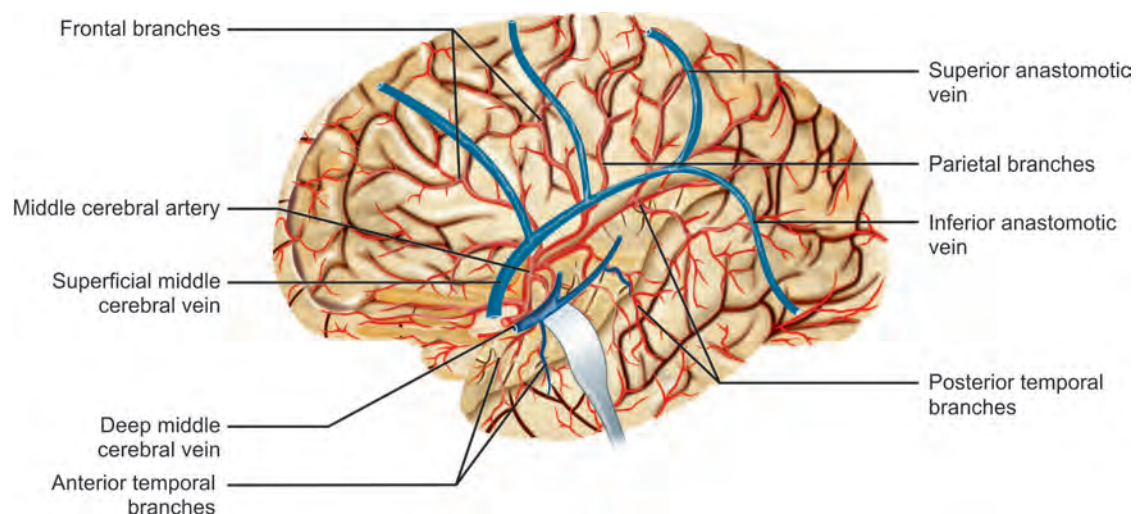


FIGURE 29: Cerebrum—blood supply of lateral surface

Deep middle cerebral vein: This lies in the depth of the limen insulae. This vein drains the insula and the neighboring gyri. It drains into the basal vein which winds the external surface of the cerebral peduncle.

Dissection: Remove these veins and look for the middle cerebral artery and its branches.

Middle cerebral artery: It is a branch of the internal carotid artery at the circle of Willis. Trace it into the lateral sulcus. Identify frontal, parietal and temporal group of branches of the artery. Note the area of supply.

Dissection: With a brain knife separate the two cerebral hemispheres by a midline cut through the corpus callosum, septum pellucidum, third ventricle to the midbrain.

The Medial and the Inferior Surface (Fig. 30)

Anterior cerebral artery: This arises from the circle of Willis. Trace it to the parietal lobe along the superior border of the corpus callosum. This artery supplies orbital 'surface' and medial surface up to the parietooccipital sulcus.

Great cerebral vein of Galen: This lies below the splenium of the corpus callosum. Trace its two tributaries—the internal cerebral vein—this runs along the roof of the third ventricle, the basal vein along the side of the midbrain. These veins drain blood from the interior part of the forebrain.

Posterior cerebral artery: Identify this artery near the temporal lobe. Identify its temporal and occipital group of branches and note its area of supply.

Anterior choroidal artery: This lies in the gap between the temporal lobe and frontal lobe by lightly separating there. This artery arises from the middle cerebral artery. *Trace the artery into the interior of the lateral ventricle through the choroid fissure.*

Posterior choroidal artery: This arises from the posterior cerebral artery near the splenium of the corpus callosum. It enters the cerebrum below the splenium to form the choroids plexus of both third and lateral ventricle.

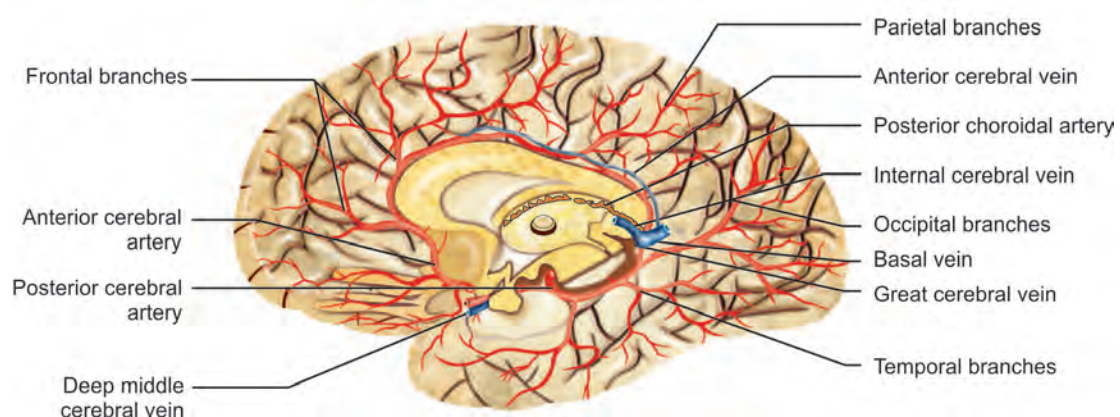


FIGURE 30: Cerebrum—blood supply medial and inferior surface



CEREBRUM

Dissection: Remove the pia mater and the blood vessels on the surface of the cerebral hemisphere leaving the central branches including the choroidal branches *in situ*.

Cerebrum moulds itself according to the shape of the cranial cavity above the tentorium cerebelli. It exhibits the following general features in a hardened specimen. Customarily it is divided into four lobes based on its relations to the bones related to the surface.

GENERAL FEATURES (Fig. 31)

Frontal pole: It is the most anterior projection, occupies the anterior cranial fossa.

Temporal pole: It is the middle projection and occupies the middle cranial fossa.

Occipital pole: It is the posterior projection, lies above the tentorium cerebelli and is related to the occipital bone above the groove for transverse sinus.

Superomedial border: This extends from frontal pole to the occipital pole.

Inferolateral border: This extends from the temporal pole to occipital pole.

Medial border: It is more blunt extends from the frontal pole to the occipital pole on the medial side. It can be described as orbital, hippocampal and occipital parts.

Superolateral surface: The area between the superomedial to inferior lateral border on the lateral aspect.

Medial surface: This extends between the superomedial border to the medial border, on the medial aspect. The two medial surfaces are separated by the falx cerebri. The diencephalon is seen below the medial surface.

Inferior surface: This can be divided into two parts **orbital surface**, the part of the frontal lobe related to the orbital plate in the anterior cranial fossa and the **tentorial surface** which includes the inferior surface of both temporal and occipital lobes and is related to the tentorium cerebelli and the middle cranial fossa.

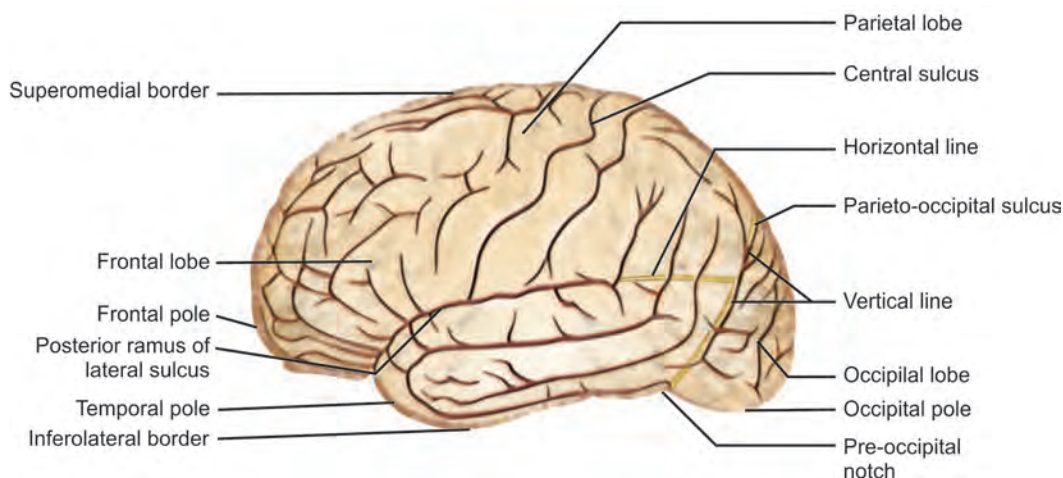


FIGURE 31: General features and lobes of cerebrum

LOBES OF CEREBRUM (Fig. 31)

Cerebrum can be divided for descriptive purposes into frontal, parietal, occipital and temporal lobes. To do this, identify the central sulcus, lateral sulcus, vertical imaginary line, horizontal imaginary line, temporo-occipital notch and parieto-occipital sulcus.

Occipital notch is a depression located between the temporal and occipital lobes.

Imaginary vertical line, look for the small parieto-occipital sulcus on the superolateral surface and draw a line from here to the occipital notch. Imaginary horizontal line—draw this line from the posterior limb of the lateral sulcus to the imaginary vertical line.

The part of the cerebrum in relation to the frontal bone, the area between the frontal pole, central sulcus and above the lateral sulcus is the **frontal lobe**. It is seen on the superolateral surface as well as the medial surface. The **parietal lobe** is the area behind the central sulcus and between the two imaginary lines drawn earlier in this area. We can see the extensions of the temporal sulci into this area. The parietal lobe extends on to the medial surface. This area is in relation to the parietal bone. The **temporal lobe** is the area between these imaginary lines, lateral sulcus and inferior lateral border. It includes the temporal pole and also extends on to the medial side. This part is in relation to the middle cranial fossa. The **occipital lobe** is the area behind the vertical imaginary line on the superolateral aspect. It includes the occipital pole and extends on to the medial side. This part lies above the tentorium cerebelli and in relation to the occipital bone.

GYRI AND SULCI ON THE CEREBRUM

The enormous expansion of the cerebral hemisphere in humans results in folding of the cerebrum, resulting in the formation of gyri and sulci. The following, describes the basic identifiable sulci, but there can be far more sulci in individual brains. The elevated area between the sulci are the gyri. **Boardman** has assigned numbers to the areas which have a common function.

Identify the following sulci and gyri on this area and study the functional areas and their numbers.

SUPEROLATERAL SURFACE (Fig. 32)

FRONTAL LOBE is the area in front of the central sulcus and above the lateral sulcus. This is primarily a motor area.

Lateral sulcus: It is a gap where the frontal, parietal and temporal lobes meet. Put your fingers in this sulcus and feel the frontal, parietal and temporal operculas, lightly separate them and see the submerged insula. Generally this sulcus is described as having a stem, anterior, ascending, and posterior rami. The anterior and ascending rami cut into the inferior frontal gyrus.

Central sulcus: This lies on the superomedial border. It starts midway between the frontal and occipital poles. It runs obliquely downwards and forwards to reach just above the lateral sulcus. It separates the frontal lobe from the parietal lobe. It is a complete sulcus, it separates two functional areas, the sensory and the motor area.

Precentral sulcus: It is the sulcus parallel and in front of the central sulcus.

Superior and inferior frontal sulci: These sulci run horizontally in the area in front of the precentral sulcus. Generally they are full sulci but many a times these are broken into smaller bits or there can be more than two horizontal sulci.

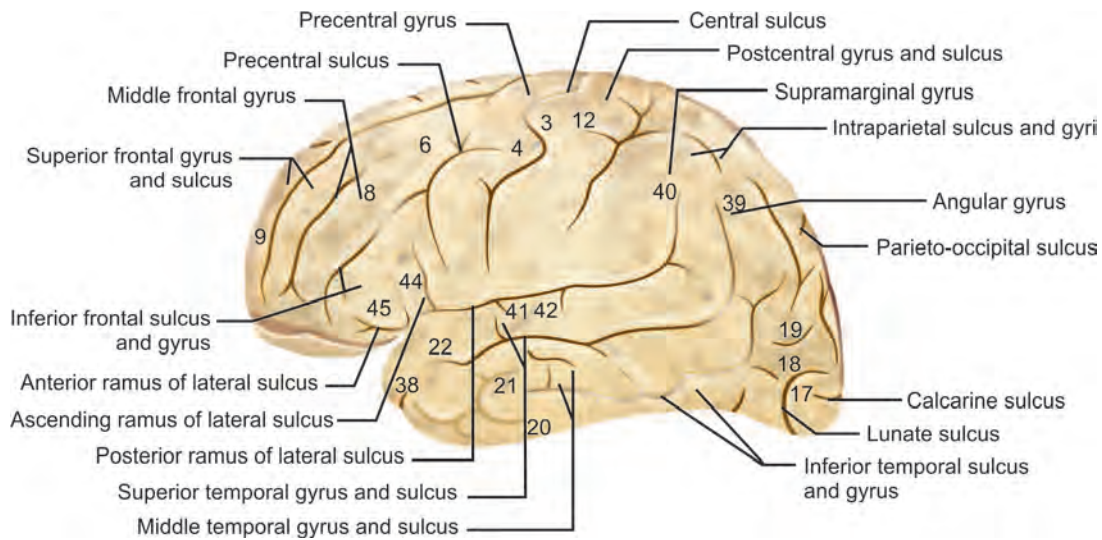


FIGURE 32: Cerebrum—superolateral surface

Precentral gyrus: It is the area between central and precentral sulcus. This is a primary motor area (area 4). The fibres starting from here control the movements of the body. They form the pyramidal tracts and relay on the motor cranial and spinal nuclei. Here the body is represented upside down. It has a big representation of the head and neck and hand as these regions perform intricate movements like speech and hand movements. **Superior and inferior frontal gyri (area, 6,8,9):** They lie in front of the precentral sulcus and between the sulci of the same. These areas in the middle frontal gyrus are given a common name, the frontal eye field. This brings about consolidated movements of the both eyeballs.

Broca's area of speech (area 44, 45): It is located in the inferior frontal gyrus. Two sulci called horizontal vertical parts of the lateral sulcus project into the inferior frontal gyrus. The area between these two and the area in front of the precentral sulcus constitutes the Broca's speech area. This brings about the coordinated movements of the muscles of larynx, mouth and face to bring about speech.

PARIETAL LOBE

Postcentral sulcus: It is the sulcus parallel and posterior to the central sulcus.

Postcentral gyrus: It is the area between the central and post central sulcus area. It perceives the general sensations like pain, touch pressure from different parts of the body in area 3. Area 1, 2 are integrating centers for the general sensations.

Intraparietal sulcus: This is an irregular horizontal sulcus within this area. The part of the lateral sulcus which projects up into the parietal lobe is called the posterior ramus of lateral sulcus.

Supramarginal gyrus (area 40): It is around the posterior limb of the lateral sulcus.

Angular gyrus (area 39): It is around the superior temporal gyrus. Wernicke's area is the area of 40, 39 including the supramarginal and angular gyri. This is an integrating center in understanding written and spoken words.

Intraparietal gyri: These are superior and inferior gyri above and below the intraparietal sulcus. This area is called parietal eye field and center for stereognosis. This area is located between general,

auditory and visual sensations. In this area integration of all these impulses takes place and their correlation with past experience, e.g. identification of a forceps in the hand even though we are not looking at it.

TEMPORAL LOBE

Superior and inferior temporal sulci: These run horizontally between the lateral sulcus and inferolateral border. Both the sulci curve superiorly into the parietal lobe.

Superior, middle and inferior temporal gyri: These lie between the sulci. Temporal lobe lodges the auditory area.

Primary auditory area (area 41, 42): This occupies the area opposite to the central sulcus on the superior temporal gyrus. This is called transverse temporal gyrus. *Lower the superior temporal gyrus to identify this.* It occupies the superior surface of this. The sounds we hear are interpreted here.

Secondary auditory area (area 21, 22): This occupies the remaining area of the temporal lobe. This area is the integrating area with our past experience and makes us understand what we heard, for example, the bell ringing sound is that of the ringing of a Church bell.

OCCIPITAL LOBE

Note this area behind the imaginary vertical line.

Lunate sulcus: It is a curved sulcus very near the pole. The area between the lunate sulcus and the imaginary line is occupied by the para and peristriate areas (area 18 and 19).

MEDIAL SURFACE (Fig. 33)

Turn the cerebral hemisphere on to the medial side and study the gyri and sulci.

Corpus callosum: This is the thick fibre bundle which connects both the hemispheres. The details will be studied with the commissures.

Callosal sulcus: It is the sulcus immediately above and around the corpus callosum.

Cingulate sulcus: This is parallel to the callosal sulcus between the superior medial border and the corpus callosum.

Medial frontal gyrus: This lies between the superior medial border and the cingulate sulcus up to the central sulcus. This area has the same 4.6.8.9.10 areas that are seen on the lateral surface.

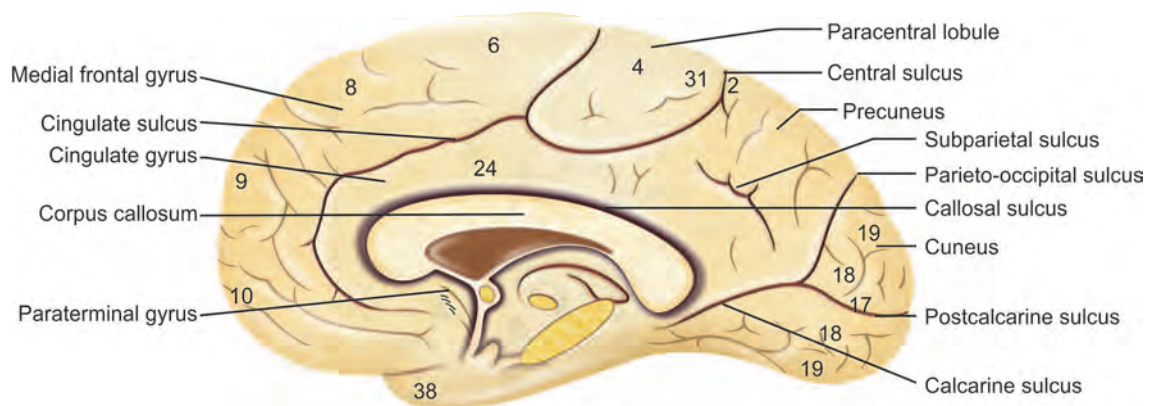


FIGURE 33: Cerebrum—medial surface

Paracentral lobule: It is the area around the central sulcus on the medial side. It has sensory as well motor areas of perineum and lower limb.

Cingulate gyrus: It is the gyrus between the cingulate and callosal sulci. This is a part of limbic lobe and is concerned with the control of internal organs.

Precuneus: It is the area between the paracentral lobule and parieto-occipital sulcus. This is the medial aspect of the parietal lobe. No particular area is assigned here. It is an integrating center.

Paraterminal gyrus: This lies in front of the lamina terminalis. This is a part of the limbic system.

OCCIPITAL LOBE

Calcarine, post-calcarine and parieto-occipital sulci form a Y shaped sulci.

Cuneus: It is the area within the Y.

Visual area (area 17): This occupies the depth and lips of the post-calcarine sulcus. This is the visuosensory area to be able to see the color and light. **Visiopsychic area** (area 18 and 19) extend on either side of the area 17. Posteriorly all the three areas are limited by the lunate sulcus. Area 18 and 19 are visual association areas where the objects are perceived by past experience.

INFERIOR SURFACE

Orbital Surface (Fig. 34)

Olfactory sulcus: Locate this longitudinal sulcus parallel to the medial border. The olfactory bulb and tract are located here. Gyrus rectus lies medial to the olfactory sulcus (area 11).

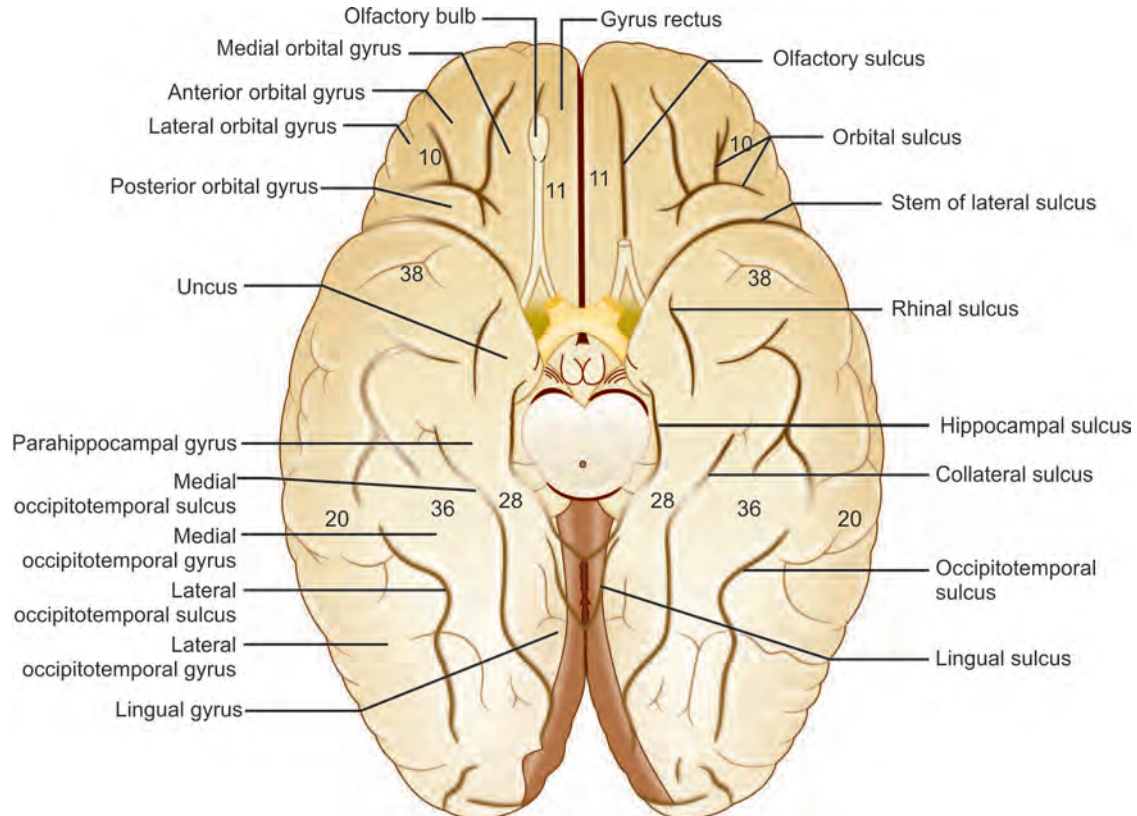


FIGURE 34: Cerebrum—inferior surface

Orbital sulcus: It is H-shaped sulcus. It occupies the remaining part of the orbital surface. Anterior, posterior, medial and lateral orbital gyri can be identified on the sides of the orbital sulci. This area is a integration center for olfactory sensations (area 10).

Temporo-occipital Surface

Rhinal sulcus: Locate this medial semilunar sulcus on the medial side.

Uncus: It is the gyrus medial to the rhinal sulcus. This is the primary olfactory area (area 38).

Parahippocampal sulcus: This is the most medial of the sulei.

Collateral sulcus: It is parallel to the parahippocampal sulcus, extends from temporal to occipital region. It is posterior to the rhinal sulcus (area 28). The gyrus medial to the collateral sulcus is parahippocampal gyrus. This is a secondary olfactory area.

Medial and lateral temporo-occipital gyri: They are on either side of the temporo-occipital sulcus. These constitute the secondary olfactory areas (area 36 and 20).

Lingual gyrus: It is posterior to the parahippocampal gyrus and lateral to the calcarine sulcus.

Insula (Fig. 35)

Insula is the submerged cortex. It is overlapped by the frontal parietal and temporal opercula. Pull these opercula and try to see the insula. The sulcus which separates the insula from the opercula is called the circular sulcus. Note the **short and long gyri** located within the insula. The point where the opercula meet is called the limen insulae. The Brodmann areas that are present on the operculum continue to be present on the overlapping opercula. The long and short gyri are concerned with the intestinal motility, taste and visceral sensations (area 43).

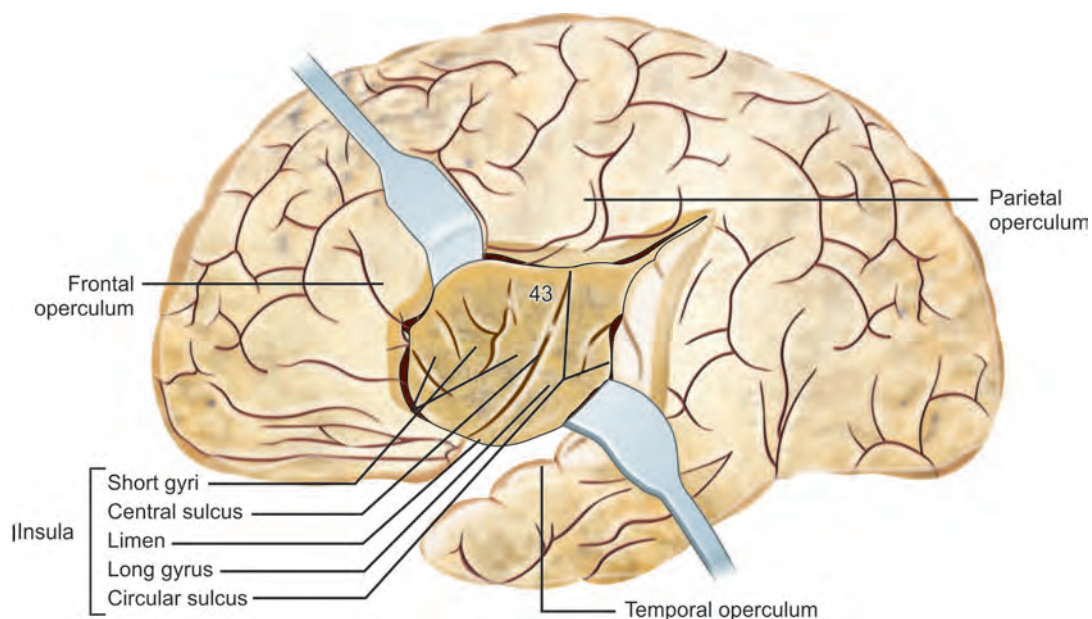


FIGURE 35: Cerebrum—insula



LIMBIC SYSTEM

Limbic lobe is the oldest in evolution and is located in and around the corpus callosum and thalamus (Fig. 36).

Turn on to the medial side and locate the following parts mostly concerned with the integration of olfactory and visceral sensations of the body.

The **olfactory bulb**: This receives the olfactory sensations from the nasal cavity through the olfactory nerves. The second order neurons traverse the olfactory tract and diverge to form the **olfactory trigone**, medial to it is the anterior perforated substance (already identified—the perforations are caused by the central arteries. Follow the **medial olfactory stria** around the gyrus rectus to the paraterminal gyrus. Trace the **lateral olfactory striae** along the floor of the limen insulae to the uncus, by pulling the uncus.

Identify the **hippocampal sulcus** medial to the uncus and parahippocampal gyrus.

Dentate gyrus: This is a thin gyrus seen in the depths of the hippocampal gyrus. Identify this gyrus by depressing the hippocampal gyrus. It shows serrations, so the name. It is continuous anteriorly with the uncus, posteriorly with the gyrus fasciolaris.

Lower the temporal lobe and identify the **pes hippocampus**, alveus and fimbria of hippocampus. These are inner to the dentate gyrus. The pes is enlarged paw like structure, *alveus* is the white fibres covering the hippocampus, the cell bodies of these fibres are located in the hippocampus.

Fimbria is the accumulation of these fibres on the medial side of the hippocampus between it and the dentate gyrus.

Fornix is the continuation of the fimbria. Trace the body, posterior and anterior columns of fornix. Majority of the fibres of the hippocampus from the fimbria ascend up towards the splenium and is called posterior column. **Posterior columns** of both sides approximate in the center to form the body. The *body* again deviates into two **anterior columns** for both the hemispheres. These end in the **mammillary bodies**. The fornix constitutes both commissural and association fibres.

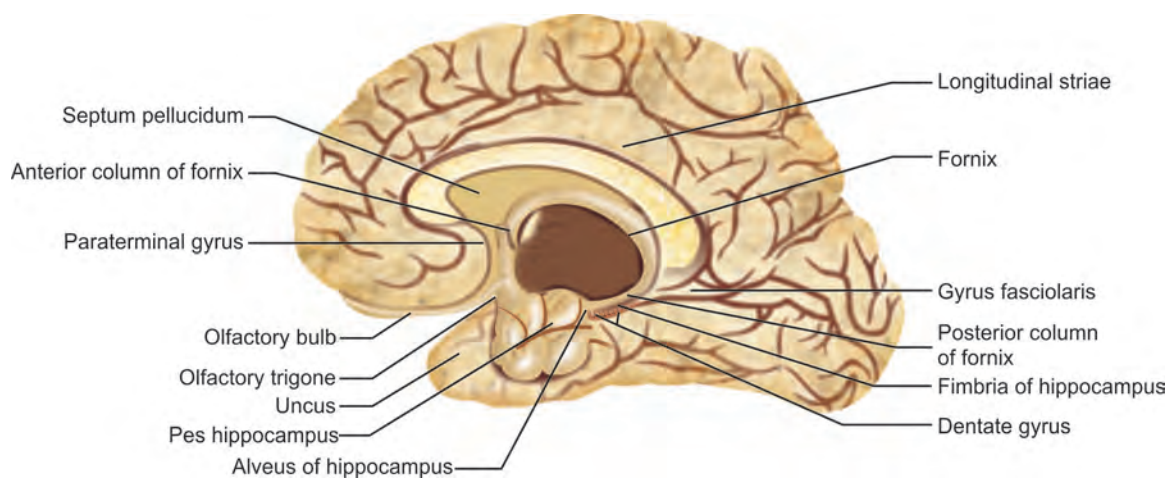


FIGURE 36: Limbic system

Few of the fibres of the hippocampus take a different route. They are **medial and lateral longitudinal striae**: Trace these two striae over the corpus callosum extending from the hippocampus to the paraterminal gyrus by pulling the cingulate gyrus.

Gyrus fasciolaris: Identify this small gyrus beneath the splenium of corpus callosum.

Paraterminal gyrus: This gyrus lies in front of the lamina terminalis.

Septum pellucidum: Septum pellucidum is a two-layered partition of the cerebral hemispheres, seen stretching between the corpus callosum and fornix. There is nuclear matter within the septum pellucidum, which is considered as a part of the limbic system. Between the two septa pellucida there is a cavity called cavity of septum pellucidum. Generally in a midline section both the layers will be seen on one side. But the layers can be peeled and the cavity can be visualized.



WHITE MATTER OF CEREBRUM

Cerebrum is the biggest integrating center. Billions of fibres are located here. For convenience of description they are described as the association fibres which connect one part of cerebral hemisphere with the other part. The commissural fibres connect one half of hemisphere with the other half of the hemisphere. As these cross the midline, in a midsagittal section these fibres get cut and are easily identified. The projection fibres connect the cerebral hemisphere with other parts of CNS. These form ascending and descending tracts. These are named by different names in different parts of the CNS.

COMMISSURAL FIBRES

Commissural fibres (Fig. 37): These connect the right and left halves of the cerebral hemispheres so they are best seen in the midline sagittal sections – *identify the following from front to back*.

ANTERIOR COMMISSURE: This lies in front of the lamina terminalis. This connects the uncus of the temporal lobe of both the hemispheres.

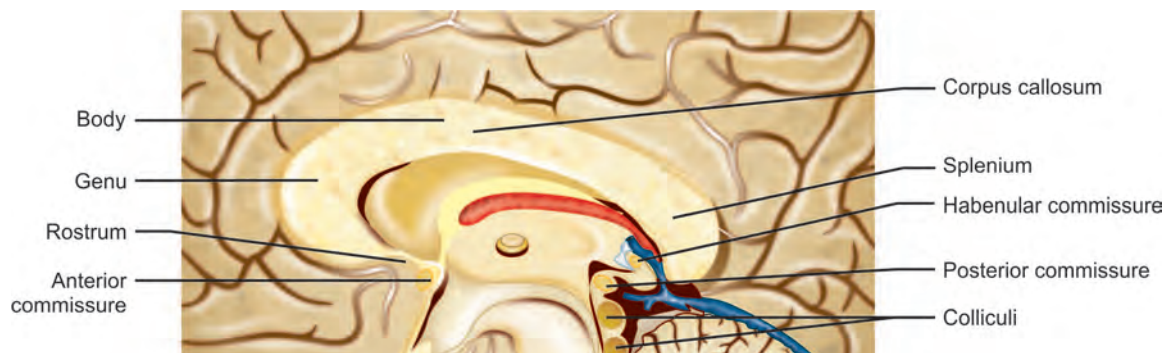


FIGURE 37: Cerebrum—white matter, commissural fibres

CORPUS CALLOSUM: This connects the frontal, parietal, occipital and temporal lobes of one side with the other. So this is the most prominent and thickest of the commissures and presents number of parts.

The **rostrum** is the thin part of the corpus callosum connecting the genu with the anterior commissure. The fibres of this part connect the two orbital surfaces.

The **Genu** is the anterior blunt pole of the corpus callosum. The fibres from here connect the two frontal lobes. The fibres of both sides form a forceps type of arrangement, so is called forceps minor.

The **body** is the main part of the corpus callosum extending from the frontal pole to the occipital pole. The fibres arising from here connect the two frontal lobes and parietal lobes. Posterior fibres from here cross laterally, lateral to the lateral ventricle, and descend down into the occipital pole. These are called tapetal fibres. Note that the fibres of the body are cut by the descending corona radiata fibres, except for the tapetal fibres.

The **splenium** is the posterior part of the corpus callosum. Fibres from here connect the parietal occipital and temporal lobes. These fibres also give an appearance of a forceps when fibres of both sides are seen. This is called forceps major.

POSTERIOR COMMISSURE: This lies posteriorly and between the pineal body and superior colliculus connects the two superior colliculi. It lies in the lower of stalk of pineal body.

HABENULAR COMMISSURE: Identify this along the upper limb of the stalk of the pineal body. It connects the two Habenular nuclei located on the posterior aspect of the thalamus lateral to the pineal body.

At this stage it is easy to study the ventricles of the forebrain, as the structures are still undisturbed.

ASSOCIATION FIBRES

Association fibres connect different parts of the same hemisphere.

MEDIAL SURFACE (Fig. 38)

Short association fibres: These are the fibres which connect one gyrus to the adjoining gyrus.

Dissection: With the back of the handle of a knife or a scalpel try to scrape the superficial gray matter on the medial frontal gyrus in the paracentral lobule. Identify the curving U-shaped fibres on either side of central sulcus. There are the short association fibres.

Cingulum: It is the big association fibre bundle in the cingulate gyrus. It extends down into the parahippocampal gyrus. It connects the frontal, parietal, occipital and temporal gyri on the medial side.

Dissection: Remove the gray matter of the cingulate gyrus by blunt dissection and note the fibres extending from the paraterminal gyrus along the frontal parietal, occipital lobes to the cuneus of the temporal lobe just external to the corpus callosum. Trace it down into the temporal lobe. These are the fibres of cingulum.

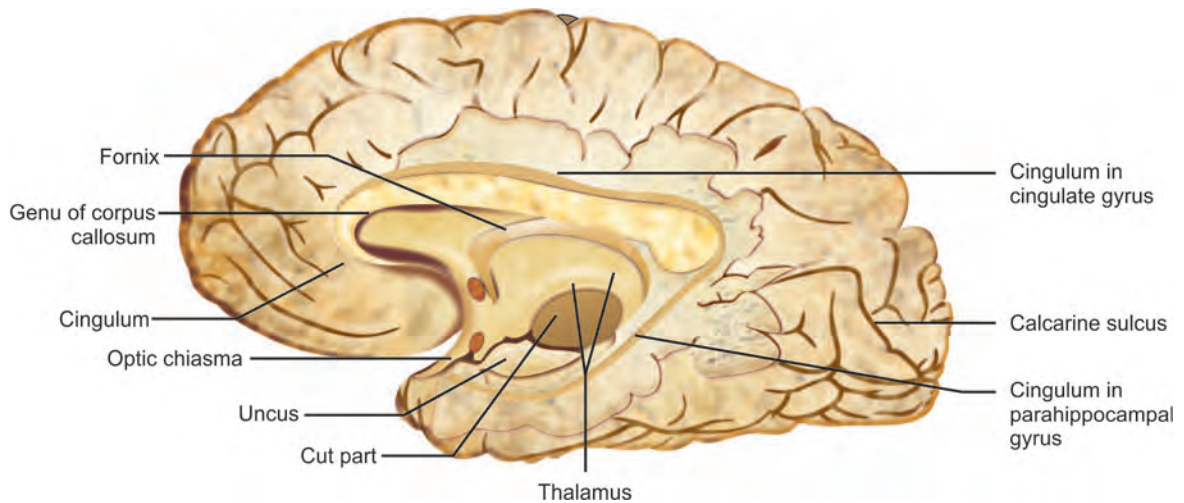


FIGURE 38: Cerebrum—white matter, medial surface

FORNIX: It has both association and commissural fibres. Deep to the cingulum you can trace the fibres of corpus callosum.

Dissection: Remove the cingulum on the medial side. Put the blunt edge of the knife along the upper border of the corpus callosum and remove the brain tissue in line with the corpus callosum. See the extension of fibres of corpus callosum into the gyri.

SUPEROLATERAL SURFACE (Fig. 39)

Dissection: Turn the brain to the lateral surface, cut the opercula of the insula to reach the circular sulcus. Then proceed by blunt dissection with the back of the handle of knife into the adjoining gyri. Identify the following association fibres.

Superior longitudinal fasciculus: It is located within the inferior frontal gyrus, supramarginal, angular gyri running horizontally from frontal lobe to the occipital lobe.

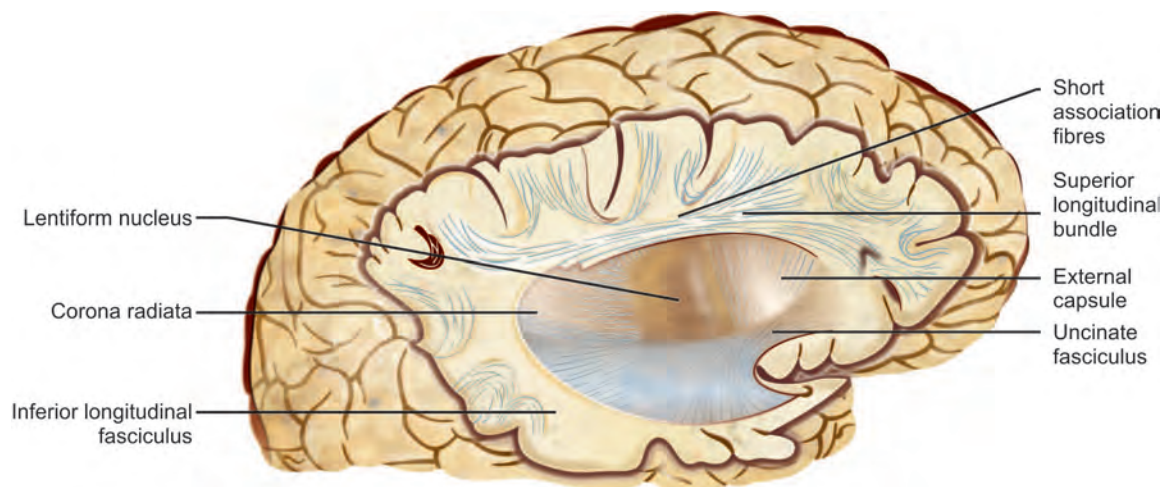


FIGURE 39: Cerebrum—white matter, lateral surface

Uncinate fasciculus: It arises from the orbital surfaces of the frontal lobe along the limen insulae to the uncus of the temporal lobe.

Inferior longitudinal fasciculus: It is seen in the inferior occipitotemporal gyrus. Remove the superficial gray matter and identify this gyrus.

Insula: It has got 4 layers—study it layer by layer by careful blunt dissection. The outer gray matter is the cortical gray. The outer white matter is the white matter of the cortex. This gives rise to projection fibres from here. The **claustrum** is a thin layer of gray matter belonging to the basal ganglia. The **external capsule** is the association fibre bundle connecting the frontal, parietal lobe to the temporal lobe. The fibres run vertically.

PROJECTION FIBRES

The projection fibres (**Fig. 40**) are vertically running fibres. These are both ascending and descending fibres to the cortex. The ascending fibres constitute thalamic radiation and the descending fibres constitute corticonuclear, corticospinal and corticocerebellar fibres. They connect the different parts of the CNS. The descending fibres begin from the gray matter of the cortex, descend down as corona radiata fibres till it reaches the upper part of corpus striatum. The same fibres within the corpus striatum are called internal capsule, and below that they descend to the midbrain where they are called crus cerebri. In the pons they form the basilar part and in the medulla oblongata they form pyramidal fibres.

Dissection: Internal capsule—It is the big vertically running fibre bundle of projection fibres. Note that the radiation of these fibres can be seen from the periphery of the lentiform nucleus in all directions. *Scoop and remove the lentiform nucleus by the back of a blade, carefully lift it totally to see the continuation of the internal capsule fibres.*

Now trace these fibres downwards into the crus cerebri. Remove the superior longitudinal fibres and trace the internal capsule fibres upwards, towards the cortex.

These are corona radiata fibres. They lie between the gray matter of the cortex to the interiorly capsule.

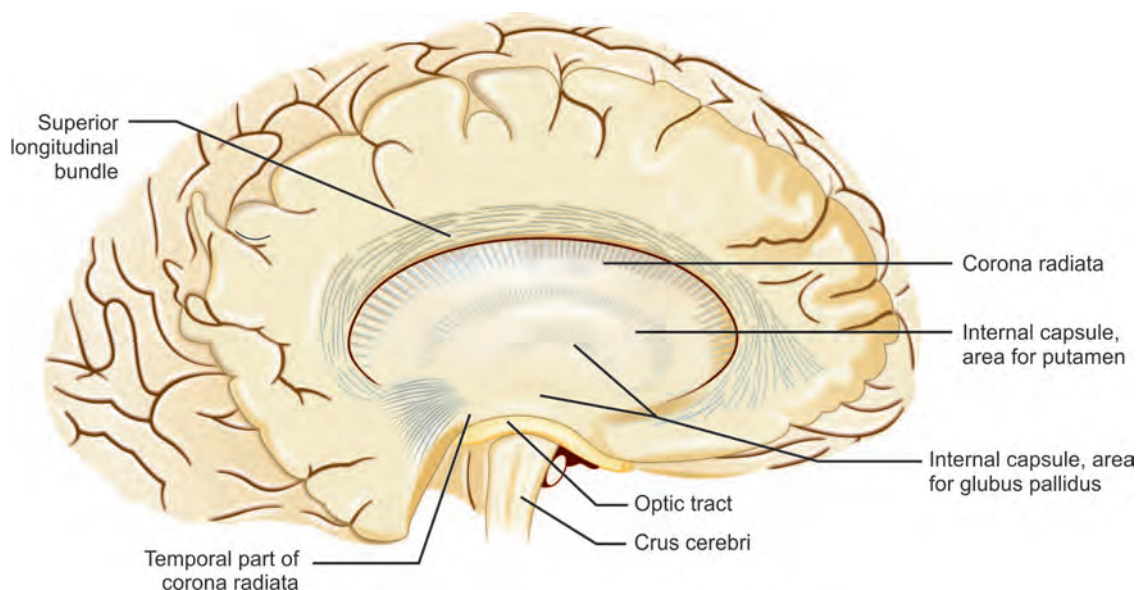


FIGURE 40: Cerebrum—projection fibres



LATERAL VENTRICLE

Lateral ventricle in the cavity to the cerebrum. It is a C shaped cavity. *Cut the septum pellucidum and the fornix to visualize this cavity.* The thalamus and the caudate nucleus forms the inner C around which lies the cavity around which lies the corpus callosum and the hippocampus.

Look for the caudate nucleus, thalamostriate vein, stria terminalis and the upper part of the thalamus in the floor of the central part of the lateral ventricle. Trace them around and note the same structures from the roof of the inferior horn. For descriptive purposes the lateral ventricle is divided into anterior horn, body, posterior horn and interior horn. Note that it is the corpus callosum which sweeps from the roof along the lateral wall to reach the floor.

The actual details can be better appreciated in coronal sections.

DEEP NUCLEAR MATTER

The white matter of the cerebrum has buried gray matter called the basal ganglia.

Basal ganglia is made up of caudate nucleus, lentiform nucleus, amygdaloid body and claustrum. The caudate nucleus and lentiform nucleus is called the corpus striatum.

Caudate nucleus: It is a comma shaped nucleus with a wide head, tapering body and a tail. It takes the curve of the cavity of the lateral ventricle. It is continuous with the putamen of the lentiform nucleus at the anterior end. The internal capsule fibres passing at this area give it a striate appearance. So the name corpus striatum.

Lentiform nucleus: It is a biconvex lens shaped structure. It has a inner globus pallidus and a outer putamen.

Amygdaloid body: It is an enlarged gray matter attached to the tip of the caudate nucleus. This will be noted in the roof of the inferior horn of the lateral ventricle.

Clastrum is external to the external capsule (identified in the white matter dissection)

All these nuclei belong to the extrapyramidal system. They have connections to the cortex and to other parts of the extrapyramidal system. The fibres arising from here control the motor nuclei of cranial and spinal nerves.

Dissection: To study the lentiform nucleus, continue the blunt dissection of the insula without disturbing the superior longitudinal, uncinat and inferior longitudinal fascicles.

Once the thin external capsule is removed the next structure noted is the lentiform nucleus. It is lightly brownish in color the shape of a biconvex lens. Feel its periphery.



THIRD VENTRICLE (Fig. 41)

Third ventricle is the space between the two diencephalons, the right and left side. Identify the boundaries,—superiorly is the **roof**. It is formed by the ependyma of the forebrain invaginated by the choroid plexus. The posterior choroidal artery feeds this. This extends from the pineal body posteriorly to the interventricular foramen anteriorly. Here it continues into the lateral ventricle. The ependyma is attached to the stria medullaris thalami the white matter which separates the third

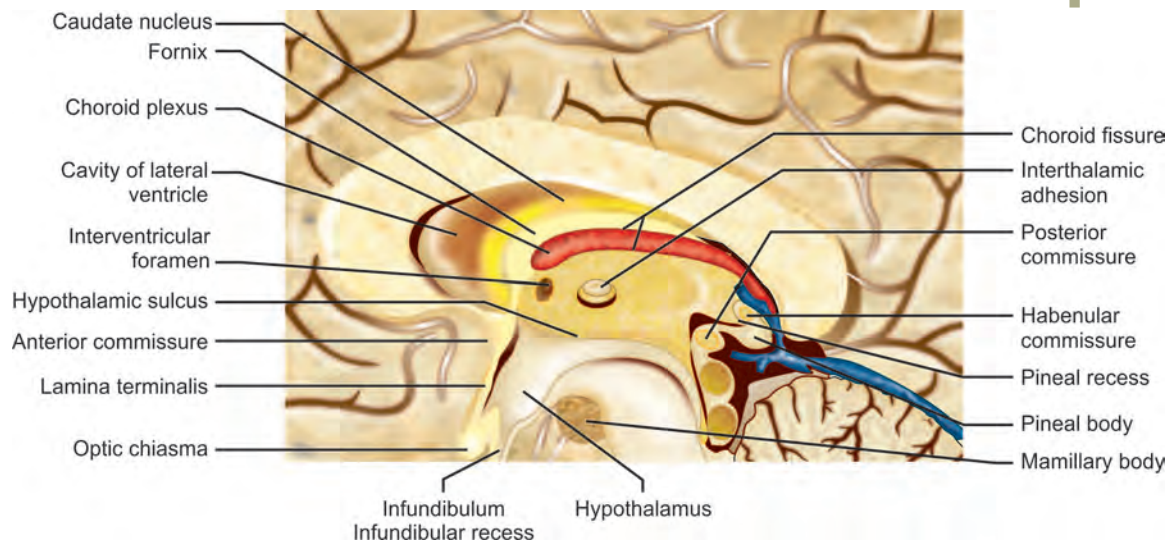


FIGURE 41: Third ventricle

ventricular part of the thalamus from the lateral ventricular part. The fornix overlies this. The gap between the fornix and the ependyma forms the **choroid fissure**.

Posterior part is formed by the epithalamus. This is constituted by the pineal gland its recess and its stalk. The pineal gland is an endocrine gland. It secretes melatonin and serotonin and influences the gonadal growth in animals. The Habenular and posterior commissures were already noted.

Anterior border is formed by lamina terminalis, optic chiasma, chiasmatic recess.

Floor is formed by the chiasma, infundibulum, infundibular recess, mamillary bodies and subthalamus.

Lateral wall is divided into two parts by the hypothalamic sulcus which extends from the interventricular foramen to aqueduct of sylvius, the part above this is bounded by thalamus and below this by the hypothalamus.

Interthalamic adhesion is generally present between the two thalami.

Interventricular foramen lies between the anterior commissure and anterior end of the thalamus. The choroid plexus of the third ventricle continues into the lateral ventricle here.



DIENCEPHALON

The diencephalon forms the submerged part of the forebrain. It is a nuclear complex and is described as having five parts—the thalamus, hypothalamus, epithalamus, subthalamus and metathalamus. It is placed around the third ventricle.

Dissection: The third ventricle is the cavity of diencephalon. It is a midline structure. In the midsagittal section the space you are seeing is the third ventricle. Identify its boundaries formed by thalamus hypothalamus and, epithalamus.

THALAMUS

Thalamus is the biggest receiving nuclear complex of the diencephalons. It is located on either side of the third ventricle. It receives all the sensory information and sends it, on to the cortex. It is divided into number of nuclear complexes, the details of which have to be studied from a textbook.

Dissection: Identify the anterior pole of thalamus behind the interventricular foramen. The body forms the lateral wall of the third ventricle. The posterior part projecting below the splenium is called the pulvinar of the thalamus. The internal medullary lamina divides the thalamus into smaller nuclear matter.

HYPOTHALAMUS (Fig. 42)

Identify the hypothalamus below the thalamus and is separated by the hypothalamic sulcus, which extends from the interventricular foramen to the aqueduct of Sylvius. It is made up of number of nuclei.

Mammillary bodies: Receive fibres through the anterior limb of fornix.

Tuber cinereum: This is the elevated part of the hypothalamus. It is connected to the pituitary gland through pituitary stalk.

EPITHALAMUS

Identify the parts of epithalamus above and posterior to the thalamus. It is formed by pineal body, habenular nucleus and its connections. **Pineal body** is a midline structure. It shows a central pineal recess, bounded by a stalk with a superior and an inferior limb. The superior limb lodges the **Habenular commissure** the inferior limb lodges the **posterior commissure**.

SUBTHALAMUS

Subthalamus is the small area between the thalamus and the midbrain.

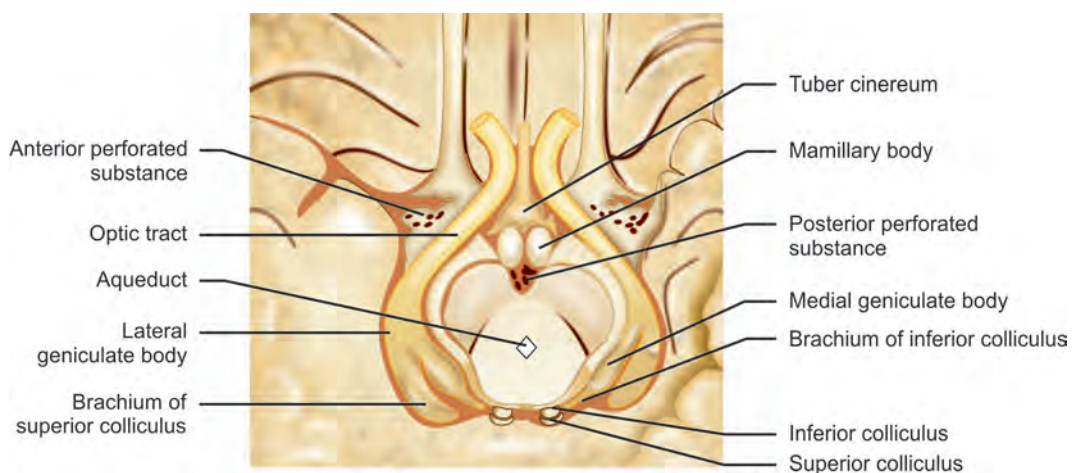


FIGURE 42: Diencephalon—Metathalamus and hypothalamus

METATHALAMUS (Fig. 42)

Metathalamus lies lateral to the thalamus and constitute medial and lateral geniculate bodies. Turn the brain to visualize the undersurface. Here you can see the metathalamus located to the lateral side of the thalamus. It is made up of lateral and medial geniculate bodies.

Lateral geniculate bodies: Trace the optic tracts into the lateral geniculate bodies. Trace it further to reach the superior colliculus, it is the superior brachium. The **optic nerves** come from the eyeball. **Optic chiasma** is where the two optic nerves exchange their fibres. **Optic tracts** begin at the optic chiasma and wind round the thalamus end in the enlarged lateral geniculate bodies. These receive the fibres of optic nerve for relay. **Superior brachium** connects the lateral geniculate body to the superior colliculus. Few of the fibres from the geniculate body reach the superior colliculus to elucidate reflex movements. Majority of the fibres sweep inside as optic radiation to reach the area 17 in the occipital pole.

Medial geniculate bodies: These lie inner and more posterior to the lateral geniculate bodies. These receive the fibres from the inferior colliculus and project it to the area 41, 42, the primary auditory area in the superior temporal gyrus.

**SECTIONS OF FOREBRAIN**

This gives a consolidated idea of the structures within the forebrain. The knowledge of this will be very much helpful in interpreting the fibres of brain.

HORIZONTAL SECTION (Fig. 43)

Dissection: Cut the cerebral hemispheres at the level of the interventricular foramen with a brain knife by a single sharp cut and separate the two halves. Study the lower half of the cerebrum.

Identify the medial, lateral surfaces, the frontal and occipital poles and locate the following features.

- Short and broad frontal pole.
- Gray matter of frontal lobe.
- White matter of the frontal lobe.
- Short association fibres.
- Genu of the corpus callosum: This is the thick anterior part that connects the two frontal lobes. Continuation of the genu is the forceps minor, identify these fibres.
- Fibres of internal capsule.

Anterior horn of lateral ventricle: Lateral wall of the anterior horn is formed by head of caudate nucleus. Anterior wall is formed by genu of corpus callosum. Medial walls formed by the septum pellucidum and fornix.

Thalamus: This occupies a prominent area in the central part of the medial side.

On the lateral aspect see:

- The frontal operculum: This covers insula anteriorly.
- Temporal operculum: This covers the inferior aspect of insula.
- Insula: This is the submerged cortex. It shows outer gray matter and inner white matter.
- Claustrum: This is another thin sheet of gray matter, part of basal ganglia.

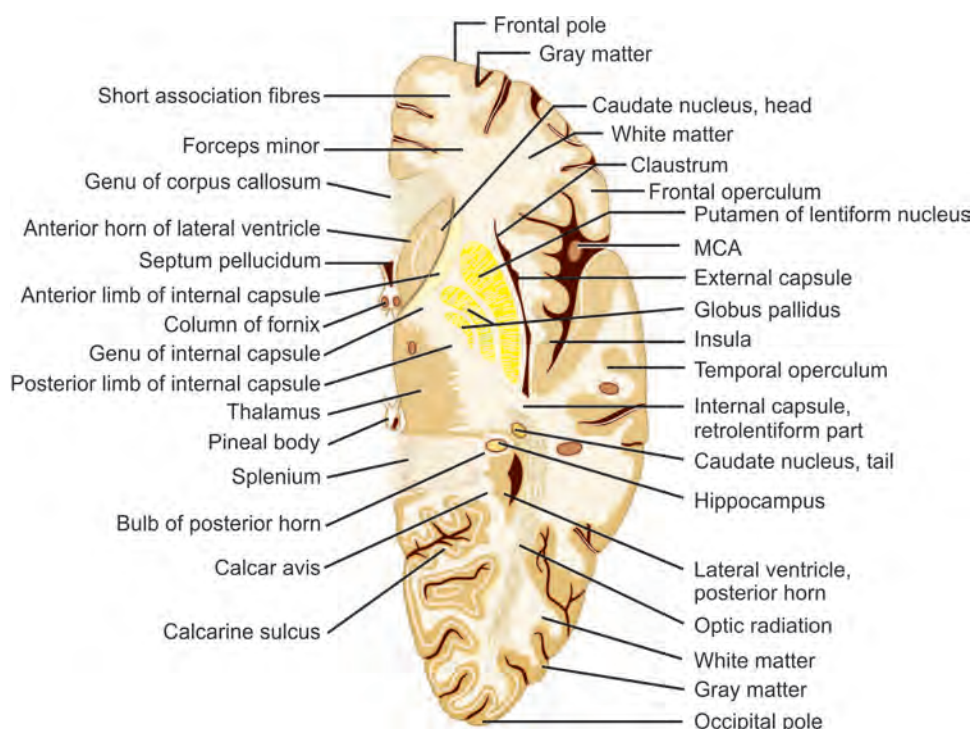


FIGURE 43: Horizontal section at the level of interventricular foramen

External capsule: The white matter over the lentiform nucleus.

Lentiform nucleus: This presents an outer darker putamen and an inner lighter globus pallidus. This occupies the area lateral to caudate nucleus and thalamus. This is a part of basal ganglia.

Internal capsule: This is the internal white matter. It presents anterior limb between the caudate and lentiform nucleus, the genu between the caudate, lentiform nucleus and thalamus, the posterior limb, between the thalamus and lentiform nucleus.

Posterior horn of lateral ventricle

Medial wall is formed by two elevations. They are the bulb, formed by the forceps major, and the calcar avis formed by the calcarine sulcus. The roof and lateral wall are formed by the tapetum of the corpus callosum.

The optic radiation: Look for the optic radiation in continuation with the internal capsule.

Splenium of corpus callosum: Identify this and the fibres arising from this are the forceps major fibres.

Calcarine sulcus: This is a prominent sulcus extending from the medial side to the inferior horn. It lodges the visual cortex.

Occipital pole: Note the gray and white matter in this lobe.

CORONAL SECTIONS

The coronal sections give a clear idea about the lateral ventricle and its boundaries.

Dissection: Take full brain if possible or at least a half a brain and cut coronal sections in the specified levels. Stain them with Mulligan stain.

CS1—THROUGH THE CENTER OF THE GENU OF CORPUS CALLOSUM (Fig. 44)

Identify the medial surface, superior, inferior and lateral sides of the section and put in anatomical position and identify the following. This shows the anterior horn of lateral ventricle.

- The anterior horn of lateral ventricle is a triangular space.
- The lateral wall forms the base and is formed by the head of the caudate nucleus.
- The genu of the corpus callosum forms the anterior limitation, superiomedial and inferomedial boundary of the triangle.
- You can note the gray and white matter of the cerebrum.

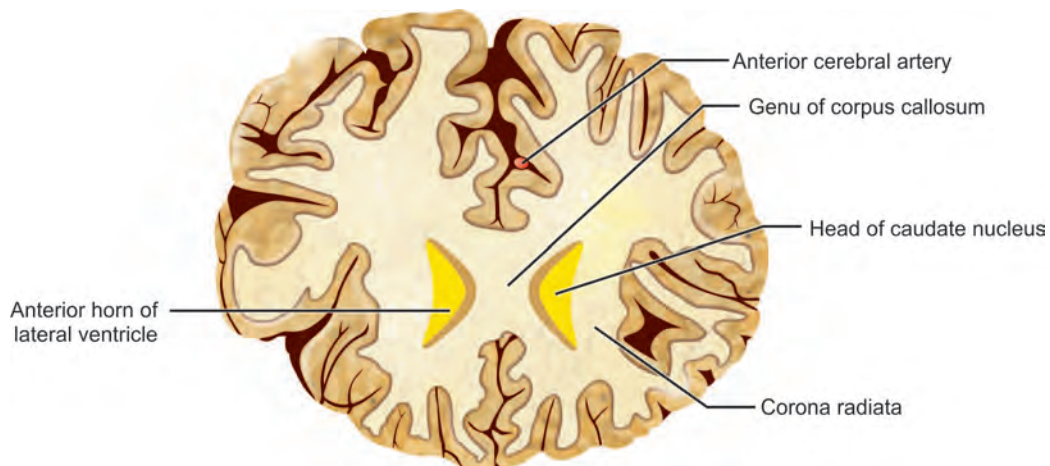


FIGURE 44: Coronal section through genu of corpus callosum

CS2—THROUGH THE OPTIC CHIASMA (Fig. 45)

- Identify the sides of the brain and put the section on a table and identify the following structures.
- This is still in front of the interventricular foramen, so shows the anterior horn of lateral ventricle.

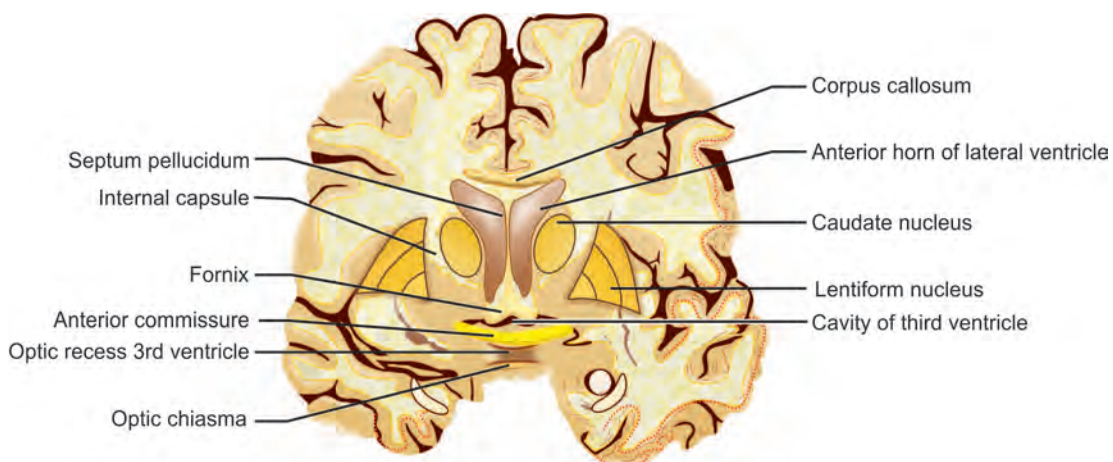


FIGURE 45: Coronal section through optic chiasma

Anterior Horn of Lateral Ventricle

On the medial side look for the septum pellucidum. Here this forms the medial boundary of anterior horn of lateral ventricle. The roof is formed by corpus callosum and the lateral wall is formed by the head of the caudate nucleus.

Corpus striatum: In this section note that the caudate nucleus and lentiform nucleus are very closely packed and internal capsule fibres are seen crossing between them giving the appearance of a layer formation, the striatum. Note the horizontally crossing anterior commissural fibres.

Peripherally look at the gray and white matter.

Clastrum: As the section goes through the insula you can identify the claustrum, one of the basal ganglia.

Midline: In the midline the fornix, cavity of third ventricle, anterior commissure, optic recess and optic chiasma lie in this order above downwards.

CS3—THROUGH THE BODY OF LATERAL VENTRICLE (Fig. 46)

- Body of the lateral ventricle
- See the boundaries.
- Superiorly note the body of the corpus callosum
- Laterally note the body of the caudate nucleus.
- In the floor note from lateral to medial, the thalamostriate vein, the stria terminalis, the choroids plexus and the thalamus.

Cavity of third ventricle: Note its cavity and note the thalamus and hypothalamus forming the lateral boundary. Fornix forms the roof. Note the choroid plexus in the roof of third ventricle. It is continuous with the choroid plexus of lateral ventricle through the interventricular foramen.

The subthalamus is the nuclear matter below the thalamus.

Inferior Horn of Lateral Ventricle

Note this in the temporal lobe. Its floor is formed by the hippocampus. Note the collateral eminence formed by the collateral sulcus. This lies lateral to the hippocampus. Note the nuclear matter in the roof. It is formed by the amygdaloid body.

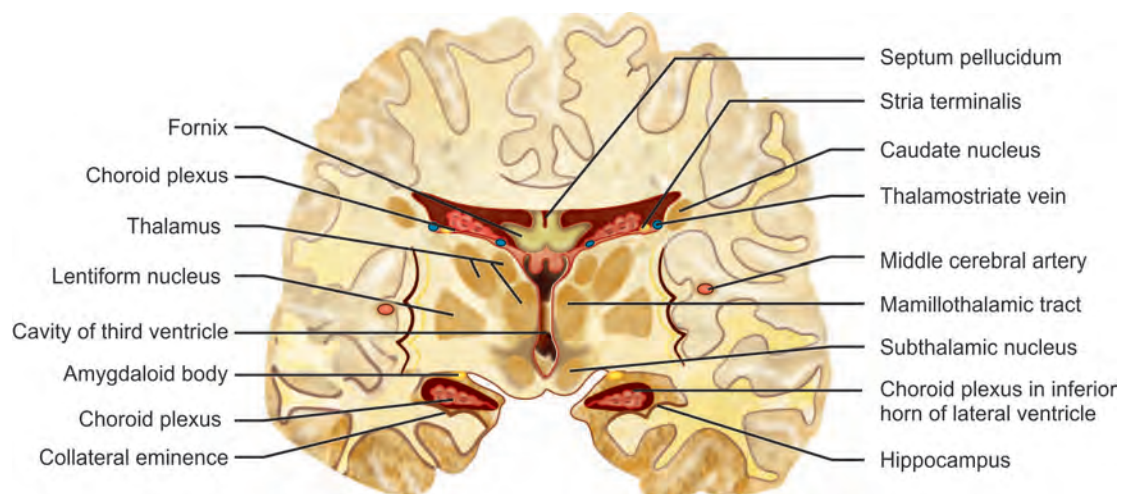


FIGURE 46: Coronal section through body of lateral ventricle

Identify the **insula** in the lateral aspect. Here note the parietal and temporal opercula. Note the gray matter of the insula, the white matter of the insula, claustrum, external capsule and the lentiform nucleus.

CS4—THROUGH THE SPLENIUM OF CORPUS CALLOSUM (Fig. 47)

Posterior Horn of Lateral Ventricle

Identify the oblong cavity of the lateral ventricle. Note the roof is formed by the splenium of the corpus callosum. The medial wall shows two elevations. The upper one is due to the projecting splenial fibres. It is called the **bulb of the posterior horn**. Note the lower elevation caused by the calcarine sulcus, it is called the **calcar avis**. Note the lateral wall is formed by fibres of **tapetum**, fibres of **optic radiation** and fibres of **superior longitudinal bundle** in that order from inner to outer.

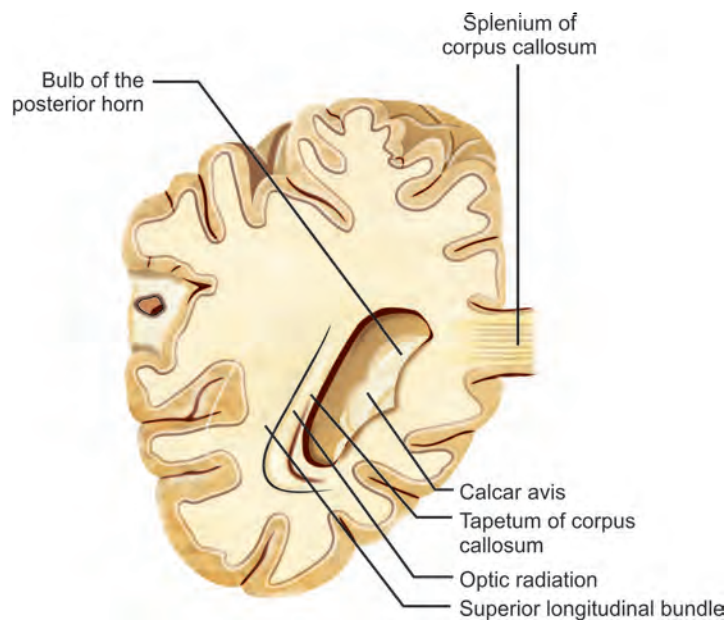


FIGURE 47: Coronal section through posterior horn of lateral ventricle

APPENDIX

MULIGAN STAIN

(A method of staining the brain for Macroscopic study—Journal of Anatomy 1931.65.468)

Cut a brain, well fixed in formalin, into slices and wash thoroughly in running water, overnight.

Place the sections for 2 minutes in a large volume of the following mixture at 60 degree centigrade.

Phenol	40 gram
Copper sulphate	5 gram
Conc. HCl	1.2 cc
Water	1 liter

Rinse in a large volume of cold water for 1 minute.

Place in 2% solution of tannic acid for 1 minute.

Wash thoroughly for 5 minutes in running water.

Place in 2% solution of iron alum till the grey matter is purplish-black. This usually requires less than 1 minutes, and the sections should be transferred rapidly to water just before the desired depth of staining is attained.

Wash well in running water.

Caution- throughout the process avoid rough handling of the section, as the fatty layer or the stained areas may easily be rubbed off.

This method depends for its success on the production of a thin, relatively impervious fatty layer on the surface of the white matter by the action of warm phenol solution on the myelin. By this means, tannic acid in aqueous solution, which can pass into the gray matter, is prevented from entering the white matter. Treatment with a soluble iron salt then produces a purplish-black coloration on the surface of the gray matter.

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